ANDERSON RIVER WATERSHED DIAGNOSTIC STUDY

ANDERSON RIVER
CRAWFORD, DUBOIS, SPENCER AND PERRY COUNTIES

PREPARED FOR:

PERRY COUNTY SOIL AND WATER CONSERVATION DISTRICT
AND
INDIANA DEPARTMENT OF NATURAL RESOURCES

PREPARED BY:

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AUGUST 29, 2007

EXECUTIVE SUMMARY

V3 Companies, Ltd. (V3) conducted a watershed diagnostic study for the Anderson River in Perry, Spencer, Crawford and Dubois counties. This study was funded by the Perry County Soil and Water Conservation District (SWCD), Perry County SWCD, Crawford County SWCD, Dubois County SWCD and the Indiana Department of Natural Resource's Lake and River Enhancement (LARE) Program. The purpose of the study is to describe the current condition and historical trends of the Anderson River Watershed and its sub-watershed components and prioritize the watershed areas in most need of land use best management conservation practices.

The Anderson River has it's origins in the southwest corner of Crawford county and flows south through portions of Dubois and Perry counties. It then defines the boarder of Perry (to the east) and Spencer (to the west) counties before discharging into the Ohio River at the state's border with Kentucky. The total watershed area is approximately 164,610 acres. The mainstem of the Anderson River is approximately 49 linear miles. The watershed also includes numerous tributaries and several lakes including the 153 acre Celina Lake (an impoundment along Winding Branch Creek), the 140 acre Indian Lake (an impoundment along Middle Fork Anderson River) and the 137 acre Tipsaw Lake (an impoundment along Sulphur Fork Creek). The Anderson River Watershed contains 56,035 acres of the Hoosier National Forest, which encompasses approximately 34% of the total watershed area.

V3 identified 25 sampling locations and delineated 25 different subwatershed partitions. Water quality, habitat and benthic aquatic macroinvertebrates were collected as means of evaluating the subwatersheds. Aerial photos, county soil surveys and previous reports were used to review the general trends in land use and development within the Anderson River Watershed. This area is predominantly forested with largely rural uses of pasture and row crops. The two dominant land uses consistently being an undeveloped forest (over 55% of the watersheds area) and agricultural use (44% of the watershed area). These two land uses currently total over 99.1% of the watershed by area. The watershed has approximately 1,863 acres of wetlands (or 1% of the watershed area) and approximately 15,450 acres within the 100-year floodplain.

The results of the Anderson River Watershed Diagnostic Study prioritized subwatersheds which are in most need of land use best management conservation practice implementation. One subwatershed was identified with the highest concern for biological community degradation, two subwatersheds were identified for having the most concern for lacking quality instream and riparian habitat, two subwatersheds were identified with the most severe spring nitrogen levels, three subwatersheds were identified with the highest concern for high bacteria concentrations and four subwatersheds were identified with the most significant loading sources for sediment and phosphorus. These subwatershed are listed by prioritization parameter:

BIOLOGICAL COMMUNITY DEGRADATION

- The area delineated as Station 16, within the 18,635 acres of the Anderson River Subwatershed. This area was the worst biologically impaired subwatershed, and the only station of this watershed study which scored within this impairment category.

LACK OF QUALITY INSTREAM AND RIPARIAN HABITAT

- The area delineated as Station 21, within the 14,647 acres of the Ferdinand Run Subwatershed. This area had the lowest score for instream and riparian habitat within the watershed, and was one of only two stations within the watershed study which was classified within the "Nonsupporting" habitat quality category.
- The area delineated as Station 23, within the 55,587 acres of the Anderson River Subwatershed. This area had the second lowest score for instream and riparian habitat within the watershed, and was one of only two stations within the watershed study which was classified within the "Nonsupporting" habitat quality category.

EXCESSIVE SPRING NITROGEN LEVELS

- The area delineated as Station 24, within the 3,563 acres of the Swinging Creek Subwatershed. This area had the only level of nitrate which exceeded the state and national water quality standards for safe drinking water. The spring result from April was 10.9 mg/L.
- Similar to the previous bullet, the area delineated as Station 22, within the 5,769 acres of the Blackhawk Creek Subwatershed had high spring nitrate levels. The result of the April test was 9.64 mg/L, which is very close to the 10.0 mg/L nitrate level of the safe drinking water standards.

HIGH BACTERIA CONCENTRATIONS

- The area delineated as Station 15, within the 7,523 acres of the Sigler Creek Subwatershed. Several of the stations exceeded the 235 cfu/100ml of E. coli bacteria state standard for surface water quality, but only one station during both spring and fall sampling had concentrations over 1,000. This station was at 1,414 cfu/100ml during both evaluations.
- The area delineated as Station 7, within the 6,103 acres of the Theis Creek Subwatershed. This station had the highest count of E. coli bacteria during this study, a value of greater than 2,420 cfu/100ml. In the fall, the value was only 147, which is below the state standard of 235 cfu/100ml.
- The area delineated as Station 4, within the 25,291 acres of the Middle Fork Anderson River Subwatershed. This station had an extremely high count of E. coli bacteria during the fall sampling effort of greater 2,420 cfu/100ml. In the spring, the value was only 66, which is well below the state standard of 235 cfu/100ml.

MOST SIGNIFICANT LOADING SOURCES FOR SEDIMENT AND PHOSPHORUS

- The area delineated as Station 20, within the 3,513 acres of the Ferdinand Run Subwatershed. This area is the most significant source of both sediment loading and phosphorus loading. The results were 0.33 tons/acre/year of sediment and 0.43 kg/acre/year of phosphorus.
- The area delineated as Station 22, within the 5,769 acres of the Blackhawk Creek Subwatershed had the second highest amount for both sediment loading and phosphorus loading. The results were 0.32 tons/acre/year of sediment and 0.42 kg/acre/year of phosphorus. Additionally, this was the only station which was previously mentioned as a priority implementation area, as it also exhibited the second worst nitrate level.

- The area delineated as Station 6, within the 6,402 acres of the Kraus Creek Subwatershed had the third highest amount for both sediment loading and phosphorus loading. The results were 0.26 tons/acre/year of sediment and 0.35 kg/acre/year of phosphorus.
- The area delineated as Station 9, within the 5,584 acres of the Little Sulphur Creek Subwatershed had the fourth highest amount for both sediment loading and phosphorus loading. The results were 0.25 tons/acre/year of sediment and 0.34 kg/acre/year of phosphorus.

ANDERSON RIVER
WATERSHED DIAGNOSTIC STUDY

TABLE OF CONTENTS

LIST OF TABLES PAGE

LIST OF EXHIBITS PAGE

APPENDICES

APPENDIX I – STATION SUBWATERSHEDS AND PHOTOS

APPENDIX II – LAND USE

APPENDIX III – THREATENED AND ENDANGERED SPECIES CORRESPONDENCE

APPENDIX IV – MACROINVERTEBRATE VOUCHER SPECIEMENS

APPENDIX V – HABITAT AND MICROINVERTEBRATE DATA SHEETS AND SAMPLING STATION PHOTOGRAPHS

APPENDIX VI – LABORATORY REPORTS

1.0 ACKNOWLEDGEMENTS

We would like to acknowledge Darlene Fischer of the Perry County Soil and Water Conservation District for her assistance with the sampling effort, assistance with historical data and coordination of the public meetings. Public meetings were held on June 27, 2006 to introduce the project, and on April 17, 2007 to discuss the findings of the watershed diagnostic study. We would also like to acknowledge Angela Sturdevant and Cecil Rich with IDNR's LARE program for guidance, review and comments. Finally we would like to acknowledge V3 staff for their involvement with research, sampling and document preparation including: Wally Levernier, Tim Kroeker, Maggie Kallai, Desiree Poole, Jessica Dunn and Ed Belmonte.

2.0 INTRODUCTION

2.1 Objectives

V3 Companies, Ltd. (V3) has provided technical services to the Perry County Soil and Water Conservation District (SWCD) in conducting a watershed diagnostic study for the Anderson River in Perry, Spencer, Crawford and Dubois counties. The purpose of the study is to describe the current condition and historical trends of the Anderson River Watershed and its sub-watershed components and prioritize the watershed areas in most need of land use best management conservation practices.

The objectives of this study is to describe the current conditions and historical trends within the Anderson River Watershed, to identify the potential threats to water quality from point and non-point source contributions, and to recommend land use best management conservation practices that will minimize harmful contributions to the Anderson River and its tributaries. The objectives also include the ability to predict the achievable success of implementing effective measures at significant locations within the watershed in order to increase water quality and the natural quality of the surrounding watershed. It is anticipated that any improvements to the subwatersheds will ultimately have a beneficial effect on the tributaries and principal waterway of the Anderson River both adjacent to and downstream of the associated best management practices.

The study was conducted in four different phases. First, V3 collected and reviewed available historical data and previous work, water chemistry data, precipitation data, and aerial and topographic maps. This information was crucial in understanding the historical and current state of the Anderson River Watershed. Second, V3 conducted field investigation surveys during which water chemistry, habitat and biological community evaluations were evaluated at both base flow and storm flow periods. Third, the locations of the field sampling stations assisted with the delineation of the Anderson River watershed by creating subwatershed partitions for the purposes of this diagnostic study. Land use information similarly compiled by these subwatershed partitions in order to construct a land use map for the Anderson River watershed. The fourth phase involved the analysis and interpretation of data collected in the previous phases of the study. The watershed management land use best management conservation practice recommendations were developed to improve the conditions within the Anderson River Watershed.

2.2 Location, Characteristics and Size of the Anderson River Watershed

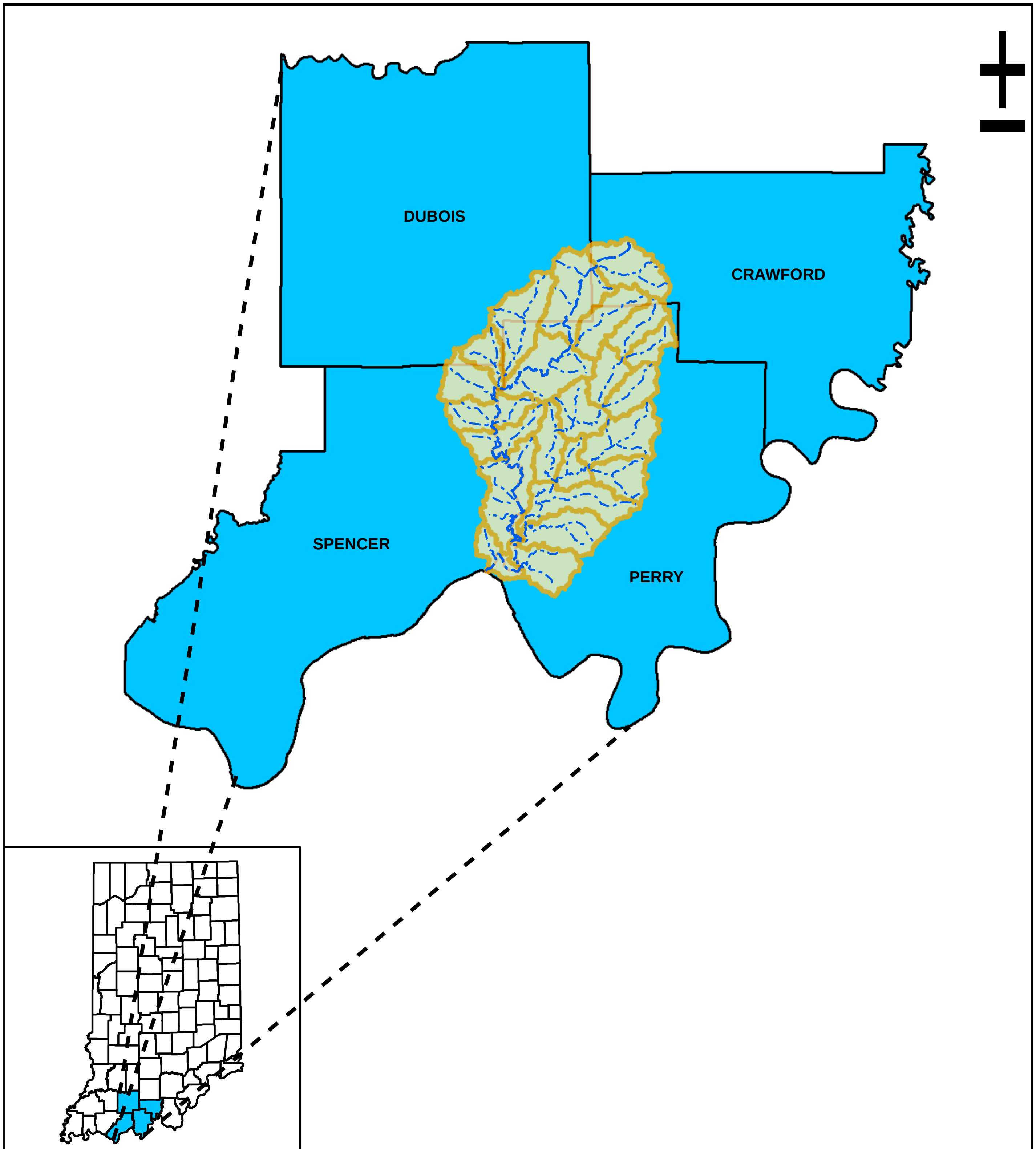
The Anderson River has it's origins in the southwest corner of Crawford county and flows south through portions of Dubois and Perry counties. It then defines the boarder of Perry (to the east) and Spencer (to the west) counties before discharging into the Ohio River at the state's border with Kentucky (Exhibit I). The total watershed area is approximately 164,610 acres and consists of two 11-digit Hydrologic Unit Codes (HUC) subwatersheds (05140201060 and 05140201070) and 23 separate 14-digit HUC subwatersheds (Exhibit II).

V3 identified 25 sampling locations and delineated 25 different subwatershed partitions which area listed in Table 1 and are shown in Exhibit III. Water quality and habitat were evaluated at all 25 stations. Benthic aquatic macroinvertebrates were collected at 19 stations as six stations did not posses the appropriate physical conditions compatible with collection methods (i.e. water depths). Photos and maps of each subwatershed are shown in Appendix I. The mainstem of the Anderson River is approximately 49 linear miles. The watershed also includes numerous tributaries and several lakes including the 153 acre Celina Lake (an impoundment along Winding Branch Creek), the 140 acre Indian Lake (an impoundment along Middle Fork Anderson River) and the 137 acre Tipsaw Lake (an impoundment along Sulphur Fork Creek). The Anderson River Watershed contains 56,035 acres of the Hoosier National Forest, which encompasses approximately 34% of the total watershed area.

TABLE 1 – ANDERSON RIVER WATERSHED, SAMPLING STATION LOCATIONS

Station Number	Waterway	Location	County	Watershed Area (acres)	Sample Parameters	Hydrologic Unit Code
Station 1	Anderson River	State Highway 545	Perry/Spencer	158,661	H, W	05140201070120
Station 2	Middle Fork Anderson River	Jones Mill (CR 13)	Perry	67,319	H, M, W	05140201060110
Station 3	Anderson River	Huffman Road	Perry/Spencer	76,146	H, W	05140201070100
Station 4	Middle Fork Anderson River	State Highway 145	Perry	25,391	H, W	05140201060050
Station 5	Brushy Fork	lower reaches	Perry	5,865	H, M, W	05140201070110
Station 6	Kraus Creek	Atlanta Road/CR 15	Perry	6,402	H, M, W	05140201060110
Station 7	Theis Creek	Atlanta Road/CR 15	Perry	6,103	H, M, W	05140201060100
Station 8	Sulphur Fork Creek	State Highway 145	Perry	17,887	H, M, W	05140201060090
Station 9	Little Sulphur Creek	French Ridge Road	Perry	5,584	H, M, W	05140201060080
Station 10	Lanman Run	Angelo Road	Perry	2,695	H, M, W	05140201070090
Station 11	Sulphur Fork Creek	Tipsaw Lake headwaters	Perry	2,809	H, W	05140201060070
Station 12	Winding Branch Creek	Celina Lake headwaters	Perry	542	H, W	05140201060040
Station 13	Middle Fork Anderson River	Indian Lake headwaters	Perry	9,056	H, W	05140201060030
Station 14	Middle Fork Anderson River	I-64	Perry	3,982	H, M, W	05140201060010
Station 15	Sigler Creek	State Highways 145 & 62	Perry	7,523	H, M, W	05140201070030
Station 16	Anderson River	CR 201A	Perry	18,974	H, M, W	05140201070020
Station 17	Anderson River	State Highway 145	Dubois	12,943	H, M, W	05140201070020
Station 18	Mitchell Creek	Mitchell Creek Road	Crawford	5,357	H, M, W	05140201070010
Station 19	Hurricane Creek	CR 2160N	Perry	10,314	H, M, W	05140201070050
Station 20	Ferdinand Run	CR 1360	Spencer	3,513	H, M, W	05140201070060
Station 21	Ferdinand Run	Route 62	Spencer	14,421	H, M, W	05140201070060
Station 22	Blackhawk Creek	Route 62	Spencer	5,769	H, M, W	05140201070070
Station 23	Anderson River	Route 62	Spencer	55,587	H, M, W	05140201070070
Station 24	Swinging Creek	CR 1300E	Spencer	3,563	H, M, W	05140201070080
Station 25	Anderson River	near Governors Trace	Crawford	3,300	H, M, W	05140201070010

H = Habitat Evaluation, M = Macroinvertebrate Data, W = Water Quality Samples



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TITLE: **Project Vicinity Map**		PROJECT: **Anderson River Watershed Diagnostic Study**	
BASE LAYER: N/A	PROJECT NO. 06002	EXHIBIT: I	SHEET: 1 OF: 1
CLIENT: Perry County Soil & Water Conservation District 125 S. Eighth Street, Room 6 Cannelton, Indiana 47520	QUADRANGLE: N/A	DATE: 1/25/07	SCALE: NTS

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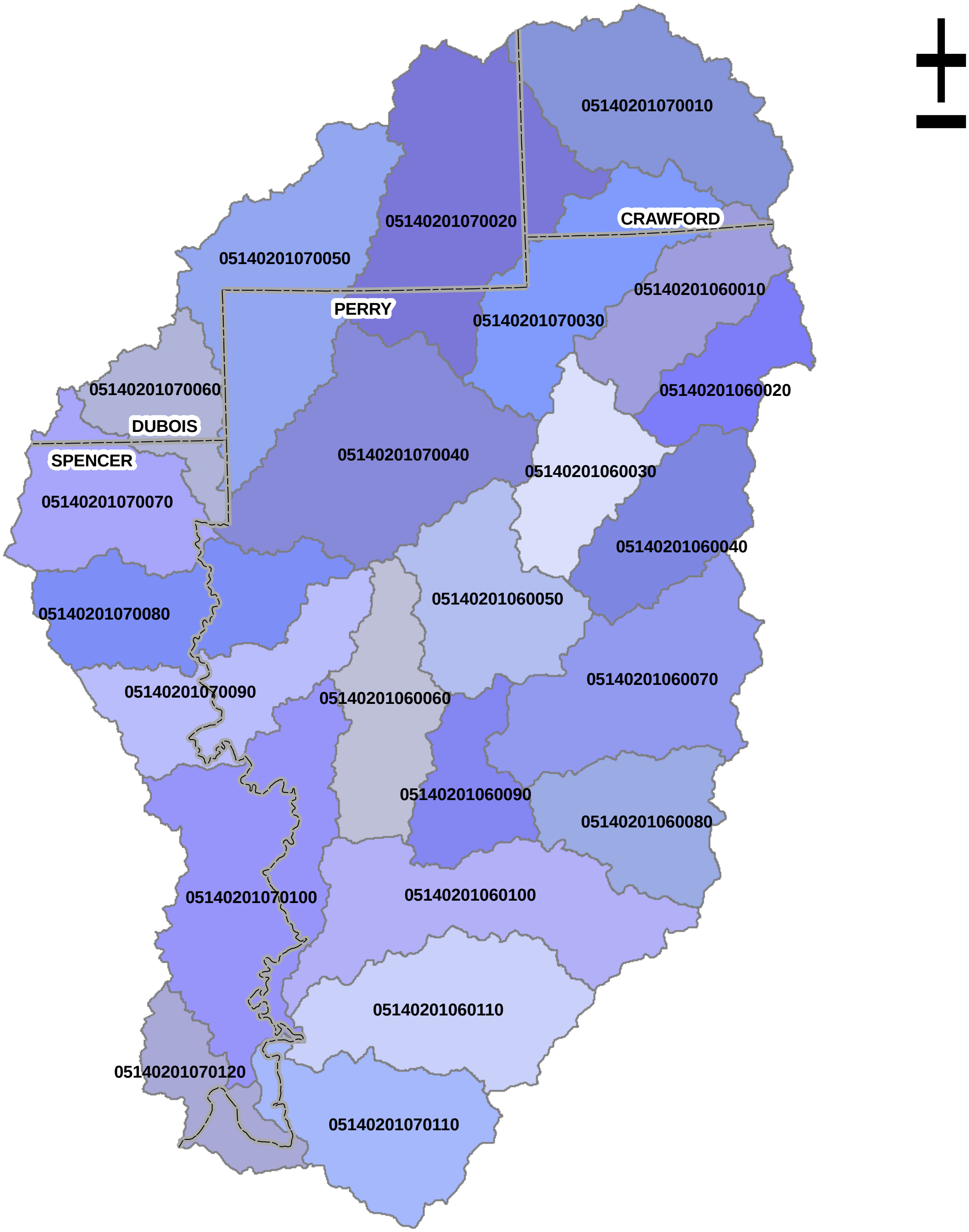

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TITLE: HUC 14-Digit Subwatersheds	PROJECT: Anderson River Watershed Diagnostic Study		
BASE LAYER: N/A	PROJECT NO. 06002	EXHIBIT: II	SHEET: 1 OF: 1
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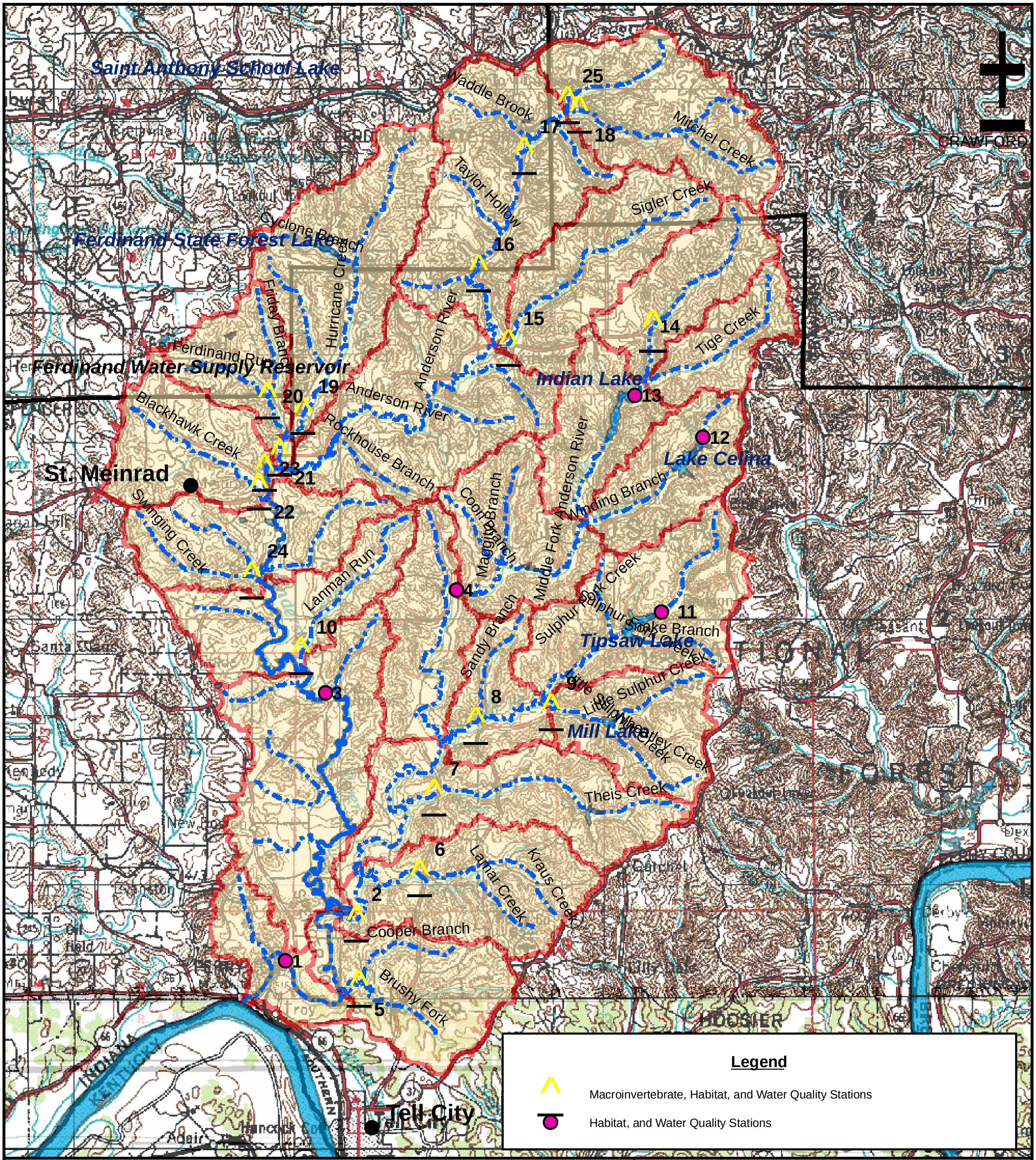

V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: **V3 Sampling Stations**	PROJECT: **Anderson River Watershed Diagnostic Study**
	BASE LAYER: Topographic Map	PROJECT NO. 06002 / EXHIBIT: III / SHEET: 1 OF: 1
	CLIENT: Perry County Soil & Water Conservation District 125 S. Eighth Street, Room 6 Cannelton, Indiana 47520	QUADRANGLE: N/A / DATE: 01/24/07 / SCALE: NTS

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2.3 Climate

The northeast portion of the basin has a mid-continental climate with well defined seasons characterized by a wide range of temperature distinguished by cold winters and hot summers. Because tropical and polar air overlap in this area, the changes in temperature and humidity are frequent. The average daily maximum temperature in July is about 87-90ºF, and the average daily minimum in January is about 19-22ºF. Typical relative humidity in the summer ranges from 40 to 90ºF or higher and in winter 60 to 90ºF. Part of the differences can be explained by changes in topography with temperatures being higher in the valleys and cooler in the hills. The lowest temperature on record occurred on January 17, 1977 and was -22ºF.

Rainfall is moderately heavy and averages between 43.8 and 44.88 inches annually. Rainfall is well distributed throughout the year, but is slightly greater in spring and summer then in the fall and winter seasons. Thunderstorms are the norm, and the intensity of rainfall is often enough to cause erosion problems on slopes with unprotected soils. Prevailing winds are from the southwest during most of the year, but in winter tend to originate in the North and northwest. Wind speeds average 10mph in the spring and 7mph in the summer. Average annual precipitation (which includes all forms of precipitation and is slightly larger than the previously mentioned rainfall range) in this portion of the basin is 45.25 inches with 54 percent falling between April and September. The heaviest rainfall occurred at St. Meinrad on May 8, 1961 and totaled 4.44 inches. The heaviest snowfall occurred on February 1, 1966 and totaled 11 inches.

The climate in the southern portion of the basin is similar to the northern portion consisting of cool and moist winters and hot and humid summers, although locally the climate can be slightly modified by the effects of Ohio River. The average growing season using 32ºF as a daily minimum temperature is approximately 160 days in the south as opposed to 155 days in the northern portion of the basin.

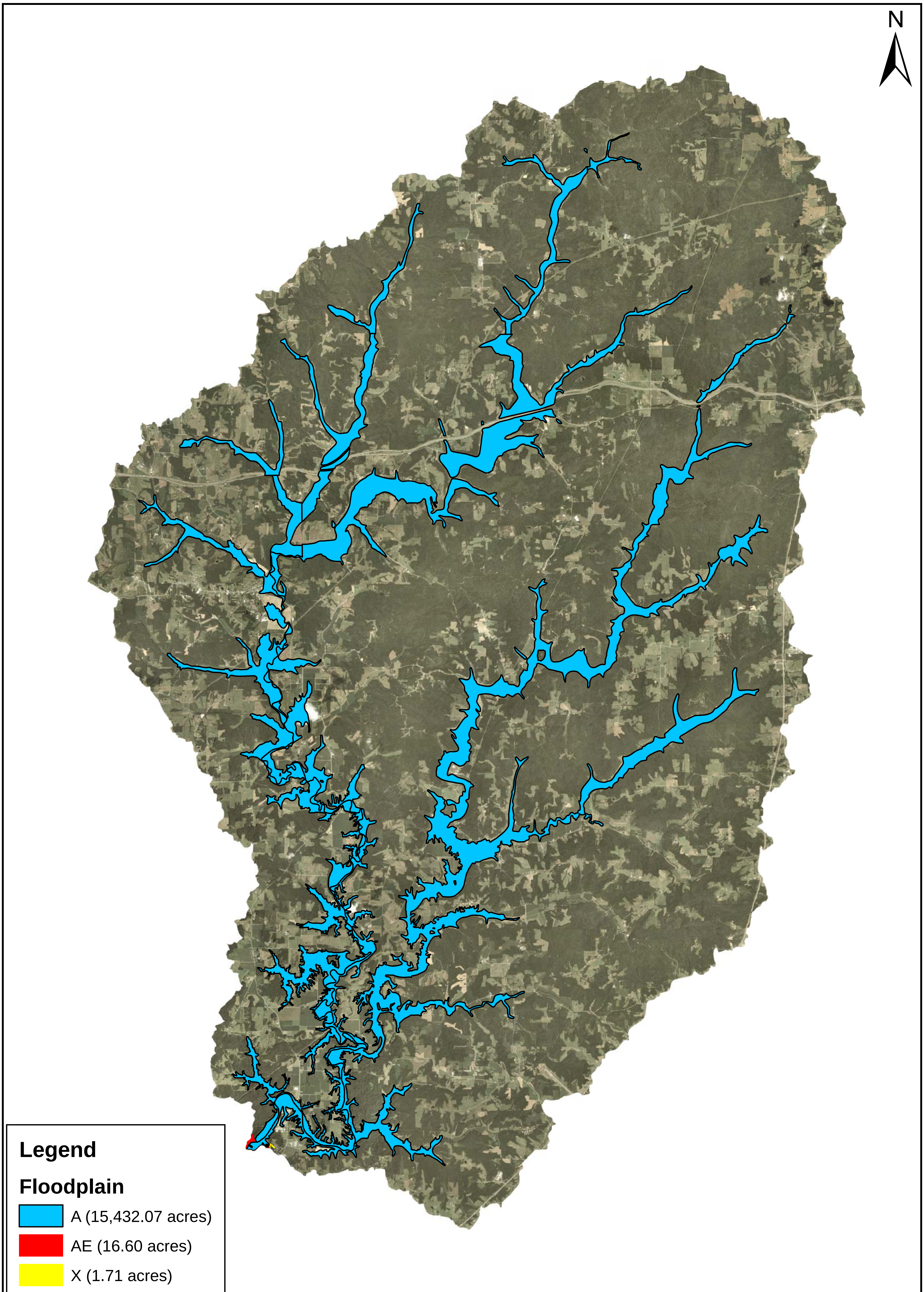
Table 2 provides historical temperature and precipitation data from Saint Meinrad.

TABLE 2 – HISTORICAL CLIMATE DATA, SAINT MEINRAD, INDIANA, 1977-2000
(Source: Midwest Regional Climate Center, 2006)

Month	Maximum Temperature (°F)	Minimum Temperature (°F)	Mean Temperature (°F)	Mean Precipitation (in)	Mean Snowfall (in)
January	40.9	23.7	32.3	3.3	3.7
February	47.3	27.5	37.4	3.2	2.7
March	57.8	36.1	47.0	4.4	1.4
April	68.1	44.4	56.3	4.5	0.0
May	76.6	53.3	65.0	4.8	0.0
June	84.2	62.3	73.3	4.1	0.0
July	87.4	66.4	76.9	4.6	0.0
August	86.3	64.7	75.5	3.9	0.0
September	80.5	57.7	69.1	3.3	0.0
October	70.0	45.8	57.9	2.9	0.0
November	56.8	37.5	47.2	4.1	0.1
December	45.3	28.3	36.8	3.7	1.7
Monthly Mean	66.8	45.6	56.2	-	-
Annual Total	-	-	-	46.6	9.6

2.4 Regulatory Floodplain

The Anderson River is located within the regulatory floodplain associated with the Ohio River, Anderson River and Middle Fork Anderson River sources. The current Flood Insurance Rate Map (FIRM) panel data for the Anderson River Watershed is shown on Exhibit IV, according to the effective Flood Insurance Study (FIS), which is documented by the Federal Emergency Management Agency (FEMA). There are three flood hazard areas identified within the watershed. Zone A, which is defined as an area inundated by 100-year flooding for which no base flood elevations (BFEs) have been established, comprises 15,432 acres (or 9% of the watershed). Zone AE, which is defined as an area inundated by 100-year flooding for which BFEs have been determined, comprises 16.6 acres. Zone X, which is defined as an area that is determined to be outside the 100-year and 500-year floodplains, comprises a mere 1.7 acres.



V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: **Regulatory Floodplain**	PROJECT: **Anderson River Watershed Diagnostic Study**		
	BASE LAYER: DFIRM and Indiana Spatial Data Service	PROJECT NO.: 06002	EXHIBIT: IV	SHEET: 1 OF: 1
	CLIENT: Perry County Soil & Water Conservation District 125 S. Eighth Street, Room 6 Cannelton, Indiana 47520	FILE NAME: N/A	DATE: 12/13/06	SCALE: NTS

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2.5 Trends in Land Development

Aerial photos, county soil surveys and previous reports were used to review the general trends in land use and development within the Anderson River Watershed. This area is predominantly forested with largely rural uses of pasture and row crops. The general trend of development is fairly stable and unchanged.

Table 3 provides total land cover acreage and percentages for the entire watershed. Land development trends are fairly stable over time with the two dominant land uses consistently being an undeveloped forest (over 55% of the watersheds area) and agricultural use (44% of the watershed area). These two land uses currently total over 99.1% of the watershed by area. Section 2.3 will discuss land use within each subwatershed.

TABLE 3 – CURRENT LAND COVER IN INDIANA, 2002
(Source: Indiana Geological Survey, Accessed 2006)

Land Use	Total Acres	Percent of Watershed
Deciduous Forest	84,402.60	51.27%
Pasture/Hay	38,332.10	23.29%
Row Crops	33,880.37	20.58%
Evergreen Forest	6,496.46	3.95%
Open Water	764.43	0.46%
Commercial/Industrial/Transportation	257.30	0.16%
Low Intensity Residential	174.10	0.11%
Woody Wetlands	141.24	0.09%
Quarries/Strip Mines/Gravel Pits	78.06	0.05%
Mixed Forest	71.40	0.04%
Emergent Herbaceous Wetlands	6.44	<0.01%
High Intensity Residential	3.35	<0.01%
Urban/Recreational Grasses	1.82	<0.01%
Totals	164,610	100%

2.6 Unique Recreational Resources

Almost 56,000 acres of the 200,000 acre Hoosier National Forest lies within the Anderson River watershed providing a host of unique recreational resources. Included in the watershed are 4 recreational areas centered on lakes. They include the Celina Lake Recreation Area, Indian Lake Recreation Area, Tipsaw Recreation Area, and the Saddle Lake Recreation Area (Exhibit V).

The Indian and Celina Lake Recreational Areas are tied together with over 16 miles of hiking trails. Included among the trails is the Rickenbaugh Interpretive Trail with stops related to the Rickenbaugh family and the historic stone house and post office. These recreational areas also provide opportunities for camping, electric motor boating and, according to locals, some of the best pan-fishing in the state of Indiana. Celina Lake and Indian Lake are 164 acres and 152 acres respectively.

Areas for picnicking are also available along with special sites to observe local wildlife. The terrain is hilly which can make hiking a challenge for some, but the trail routes have areas along the way that have been opened up and maintained which afford opportunities to see deer, turkey, quail, songbirds, and other wildlife species, as well as a variety of plant life.

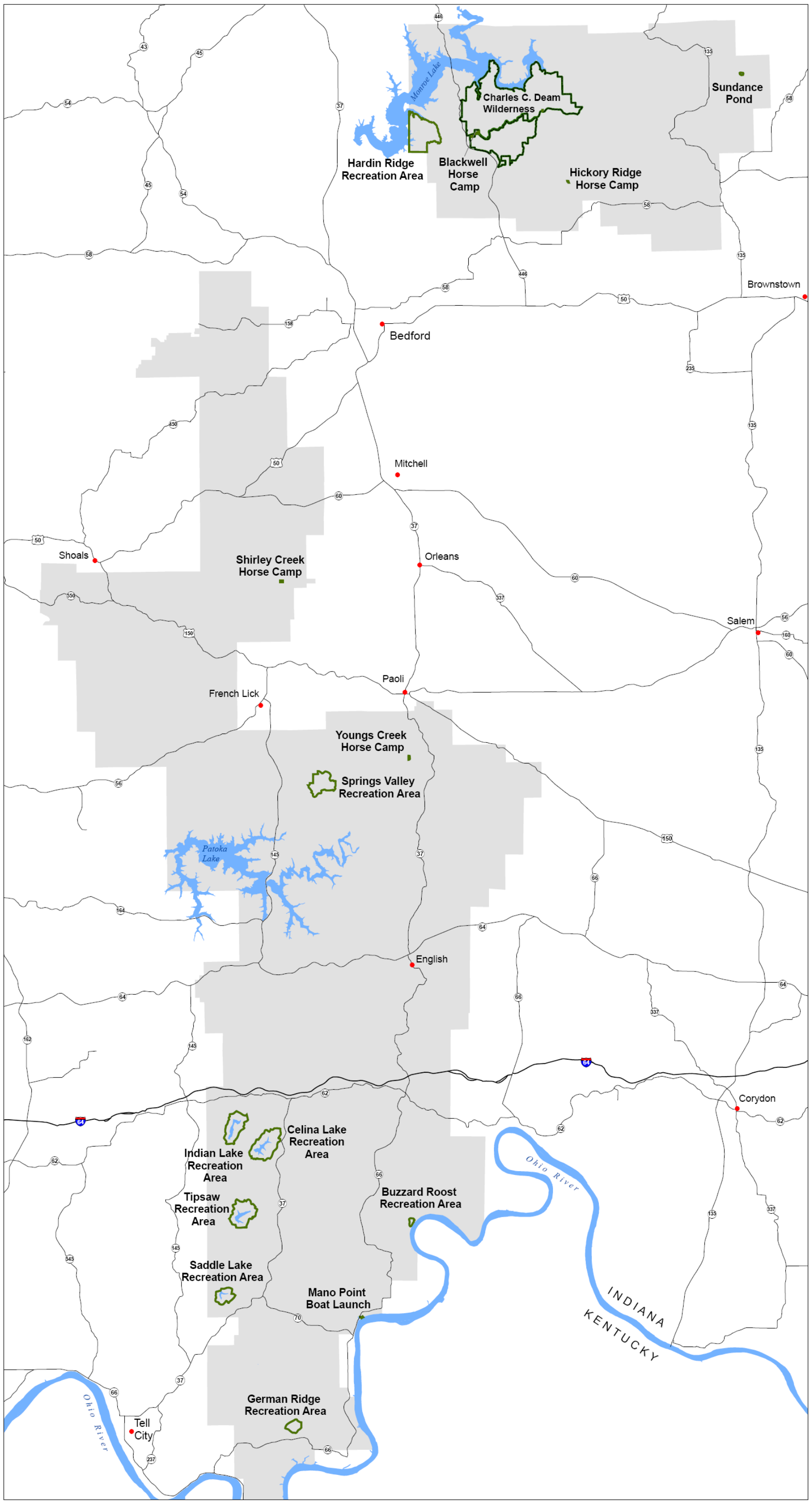
The Tipsaw Recreation Area complex is located on the shores of 131-acre Tipsaw Lake. It also offers opportunities for camping, hiking, biking, picnicking, swimming, boating, and fishing. Other areas in Hoosier National Forest also allow for horseback riding, The Tipsaw Recreation area also offers two group camps with capacities of up to 250 people. There are 15 picnic sites and two shelter houses over looking the lake near the beach, and as is the case with Celina and Indian Lakes, the pan-fishing is excellent. The beach also has a modern bathhouse which is open from Memorial Day through Labor Day weekends.

Saddle Lake also has opportunities for fishing, boating, and hiking although camping is restricted to 13 non-electrical sites.

Hunting is also allowed in many portions of the Hoosier National Forest. These opportunities range from easily accessible sites off roads to more difficult areas where hunters need to hike in. Special Disabled Hunting Areas are also available in Hoosier National Forest.

Ferdinand State Forest is also in the Anderson River watershed and consists of 7,657 acres. Camping, hiking, mountain biking, swimming, fishing, hunting, bird watching, photography and numerous passive outdoor recreational activities can be pursued at the State Forest. Boating is only limited to electric motors only.

Other sites nearby that provide opportunities for recreation but are not located within the basin include Lincoln State Park and Lincoln Woods Nature Preserve, O'Bannon Woods State Park, Patoka Lake Reservoir, German Ridge Recreation Area, Buzzard Roost Recreation Area, the Orangeville Rise of the Lost River Nature Preserve, and of course, the mighty Ohio River.



Hoosier National Forest

Recreation Sites

N
W E
S

0 4 8 12 16 Miles

- Interstate
- Highway
- Recreation Sites
- Wilderness
- Lakes/River
- Hoosier NF Boundary

Original data was compiled from multiple source data and may not meet National Mapping Accuracy Standards. For specific data source dates or additional digital information contact the Hoosier National Forest Supervisors Office. No warranty is made to the contents or accuracy of the data.

2006

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TITLE: Hoosier National Forest Recreational Areas	PROJECT: Anderson River Watershed Diagnostic Study		
BASE LAYER: N/A	PROJECT NO. 06002	EXHIBIT: V	SHEET: 1 OF: 1
CLIENT: Perry County Soil & Water Conservation District 125 S. Eighth Street, Room 6 Cannelton, Indiana 47520	QUADRANGLE: N/A	DATE: 1/31/07	SCALE: NTS

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3.0 CURRENT WATERSHED CONDITIONS

3.1 Watershed Boundaries

The watershed boundary that was agreed upon as a result of discussions with LARE program staff as this study began was to evaluate the entire 164,610 acre watershed, but that no recommendations would be made by this report to change any of the land use activities within federally owned and managed lands. The watershed extends from the northern most portions near St. Meinrad in Crawford County, through the southwest corner of Crawford County and the southeast corner of Dubois County. The watershed is then represented by the western most portion of Perry County and the eastern most portion of Spencer County, before it terminates at the Ohio River along the state border of Indiana and Kentucky.

3.2 Soils and Geology

Indiana bedrock formations have been assigned ages that place them in the Paleozoic Era. Paleozoic Era literally means "old life" meaning the creatures living in that time period were many, but were not considered very advanced (Clark, 1980). The principal bedrock formations in the Anderson River watershed that were laid down during this period are associated mainly with rocks of Pennsylvanian age consisting of Shale and Sandstone, and some of Mississippian age consisting of Limestone, siltstone, sandstone, and shale (Hall, 1998).

Parent materials are the unconsolidated mass in which a soil forms. The Anderson River lies in the small unglaciated portion of Indiana, so rather than these parent materials mainly being deposited by glaciers as they are in much of the state, soils are formed from a residuum (or residual soil material) from sandstone, limestone, siltstone, or shale. However, even in this unglaciated region of the state, glaciers have had their impact on the soil formation in the Anderson River basin. Much of the windblown loess (fine grained material deposited by wind), and silt and clay sediments of old lakes, alluvium from old stream deposits, and alluvium (deposited by floodwaters) on present flood plains of streams was originally derived from glacial deposits. The majority of the watershed's bedrock geology is within the Raccoon Creek Group of sandstone, shale, limestone and thin coals. Portions of the eastern watershed have interspersions of the West Barden and Stephensport bedrock geology Groups of upper Chesterian rocks, shale, sandstone and limestone.

There are hundreds of different soil types throughout Indiana based on their unique characteristics (Exhibit VI). Each county arranges these soil types by like characteristics into groups, or major Soil Associations. These soil associations can give one an overall feel for the soils in the county, but should not be used at the farming level for decision making. The major soil associations for the four counties with land in the Anderson River watershed are listed in Table 4 along with their general characteristics, the percent of the county where they are found, and their use.

In Rural areas, households often depend on septic tank absorption fields. The ability of these waste treatment systems is dependant on gradual seepage of wastewater into the surrounding soils. This can easily be achieved where favorable soil characteristics and geology exist. In the situations where unfavorable conditions exist, either the seepage of wastewater is too fast or too slow, then modifications may be made to the location where the septic tank absorption field is to be placed. For example, mounds may be used in areas that are too wet. The county health departments are able to assist landowners with these situations.

TABLE 4 - MAJOR SOIL ASSOCIATIONS FOR COUNTIES WITH LAND IN THE ANDERSON RIVER WATERSHED*

Soil Association	Characteristics	County Coverage	Use
Perry County			
Gilpin-Muskingum-Wellston	Moderately deep and deep, well drained, medium textured, gently sloping to very steep soils on uplands	54%	Mostly wooded, some pasture, if cropped, erosion is a serious problem
Zanesville-Tilsit	Deep, well drained and moderately well drained, medium textured, nearly level to strongly sloping soils with brittle, slowly permeable or very slowly permeable fragipan in the lower part of the subsoil; on uplands	24%	Crops and Pasture (Corn, soybeans, small grains, meadow) Some wooded, shallow root zone.
Haymond-Pope-Elkinsville	Deep, well drained, medium textured, nearly level to sloping soils on flood plains and old stream terraces.	10%	Crops and Pasture (Corn, soybeans, wheat, meadow)
Wheeling-Huntington-Weinbach	Deep, well drained to somewhat poorly drained, medium textured, nearly level to sloping soils on stream terraces and flood plains	7%	Crops and Pasture, if managed properly, can be used for intensive row cropping. (Corn, soybeans, small grains, meadow)
Markland-Henshaw-Uniontown	Deep, well drained to somewhat poorly drained, medium textured, nearly level to steep soils on stream terraces	5%	Forest or Crop Land (Corn, soybeans, wheat, meadow)
Spencer County			
Zanesville-Wellston-Tilsit	Deep and moderately deep, well drained and moderately well drained, medium textured, nearly level to very steep soils on uplands	41%	Small grains and meadow
Hosmer	Deep, well drained, medium textured, gently sloping to sloping soils on uplands	10%	Corn, soybeans, small grains, pasture
Alford-Ragsdale	Deep, well drained, and very poorly drained, medium textured, nearly level to very steep soils on uplands	11%	Corn, soybeans, small grains, hay, pasture, hard woods
Markland-McGary-Uniontown-Henshaw	Deep, well drained to somewhat poorly drained, medium textured and moderately fine textured, nearly level to steep soils on terraces	13%	Corn, soybeans, small grains, hay, pasture
Weinbach-Wheeling	Deep, somewhat poorly drained and well drained, medium textured, nearly level to sloping soils on terraces	16%	Corn, soybeans, small grains, hay, pasture
Stendal-Philo-Huntington	Deep, somewhat poorly drained to well drained, medium textured, nearly level soils on bottom lands	9%	Corn, soybeans, pasture
Crawford County			
Haymond-Wakeland	Nearly level, deep, well drained and somewhat poorly drained, medium textured soils on bottom lands	1%	Corn, soybeans, meadow, pasture
Tilsit-Johnsburg	Nearly level and gently sloping, deep, moderately well drained and somewhat poorly drained, medium textured soils with brittle very slowly permeable subsoil; on uplands	7%	Corn, soybeans, small grains, pasture
Hagerstown-Crider	Gently sloping to steep, deep well drained, medium textured and moderately fine textured soils on uplands	6%	Corn, soybeans, small grains, meadow, pasture
Wellston-Gilpin-Zanesville-Berks	Moderately sloping to very steep , moderately deep to deep, well drained medium textured soils on uplands	85%	Corn, soybeans, small grains, meadow, timber production
Markland-Wheeling-Huntington	Nearly level to very steep, deep, well drained, medium textured and moderately fine textured soils on terraces and bottom lands	1%	Corn, soybeans, small grains, meadow

Dubois County			
Gilpin-Zanesville-Berks	Moderately deep and deep, moderately sloping to very steep, well drained soils; on uplands	28%	Hay, pasture, woods. Poor potential for cultivated crops
Zanesville-Gilpin-Tilsit	Deep and moderately deep, nearly level to moderately steep, well drained and moderately well drained soils; on uplands	44%	Hay, pasture, some cultivated crops, woodland.
Stendal-Steff-Cuba	Deep, nearly level, somewhat poorly drained to well drained soils; on floodplains	14%	Cultivated crops, hay, pasture, woodlands
Otwell-Dubois-Peoga	Deep, nearly level to moderately sloping, well drained to poorly drained soils on lake plains and terraces	11%	Cultivated crops, hay, pasture, woodlands
Pike-Negley-Parke	Deep, nearly level to very steep, well drained soils; on lake plains and outwash terraces	2%	Cultivated crops, hay, pasture
Alford-Princeton	Deep, gently sloping to very steep, well drained soils; on uplands	1%	Hay, pasture, some cultivated crops, woodland.

*Information taken from the Soil Conservation Service Soil Surveys for each county.

Highly Erodible Soils

Exhibit VIII shows Highly Erodible Land (HEL) soils mapped in Anderson River watershed. This data was collected from the NRCS offices of Crawford, Dubois, Perry, and Spencer Counties. HEL account for 78% of the entire watershed.

Of the 24 total types of HEL soils listed for Crawford County, the Anderson River watershed has six types mapped which encompass approximately 4,480 acres, or 35% of the watershed within the county (Table 5).

Of the 21 total types of HEL soils listed for Dubois County, the Anderson River watershed has 10 types mapped which encompass approximately 16,153 acres, or 86% of the watershed within the county (Table 6).

Of the 33 total types of HEL soils listed for Perry County, the Anderson River watershed has 27 types mapped which encompass approximately 91,486 acres, or 84% of the watershed within the county (Table 7).

Of the 45 total types of HEL soils listed for Spencer County, the Anderson River watershed has 31 types mapped which encompass approximately 17,024 acres, or 70% of the watershed within the county (Table 8).

TABLE 5- HEL SOILS CRAWFORD COUNTY

AfE2	CoF	CrC2	ElC2	GlE2	GlE3
GpE	HaD2	HaE2	HgC3	HgD3	MaD2
MaF	McC3	McD3	TB2	WeC2	WeC3
WeD2	WeD3	WhC2	WhE2	ZaC2	

TABLE 6 – HEL SOILS DUBOIS COUNTY

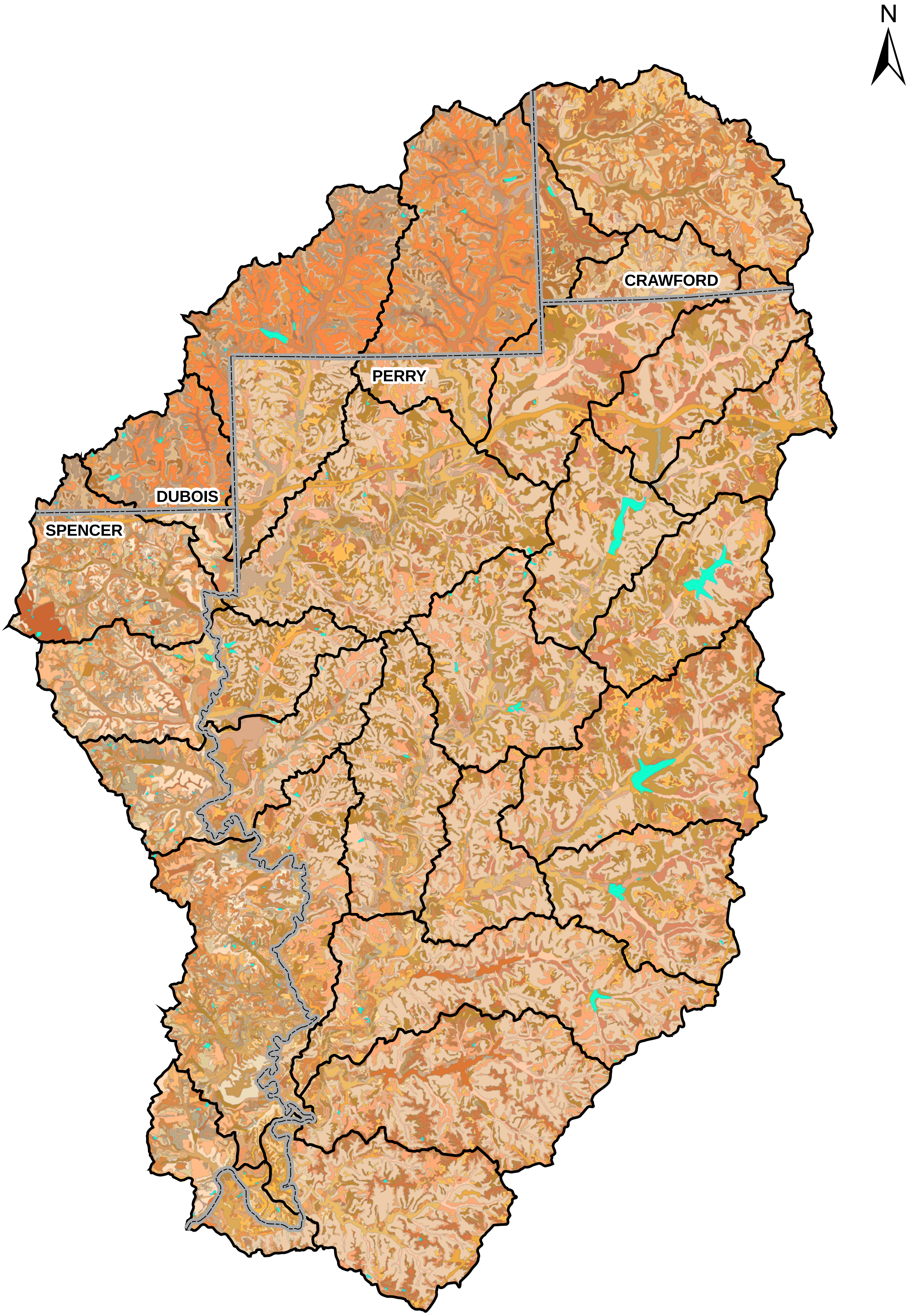
GlD2	GlD3	GlE	GlE3	GoF
GuD	WeC2	WeC3	ZnC2	ZnC3

TABLE 7- HEL SOILS PERRY COUNTY

AbvD2	AbvD3	AccG	AcuF	AfzG	AgrB	AgrC2	AgrC3	BkeC2
CwaAH	DduC2	EabD2	EabD3	EamAQ	JoeG	McgC2	McnGQ	McpC3
McuDQ	MsbC2	RgvB	RgvC2	RgvC3	RgvD3	ScdB	TakC	TakD

TABLE 8- HEL SOILS SPENCER COUNTY

GmF	HoB2	HoC3	MkB2	MkC2
MkD2	MkE	MlB3	MlC3	MlD3
PeB2	TsB2	TsB3	UnB3	UnC2
UnC3	UnE2	WeB	WeC2	WeC3
WeD2	WeD3	WeE2	WeE3	WhB3
WhC2	ZaB2	ZaC2	ZaC3	ZaD2
ZaD3				



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	BASE LAYER: Soil Data Mart	PROJECT NO.: 06002 / EXHIBIT: VI / SHEET: 1 OF: 1
	Client: Perry County Soil & Water Conservation District, 125 S. Eighth Street, Room 6, Cannelton, Indiana 47520	FILE NAME: N/A / DATE: 12/13/06 / SCALE: NTS

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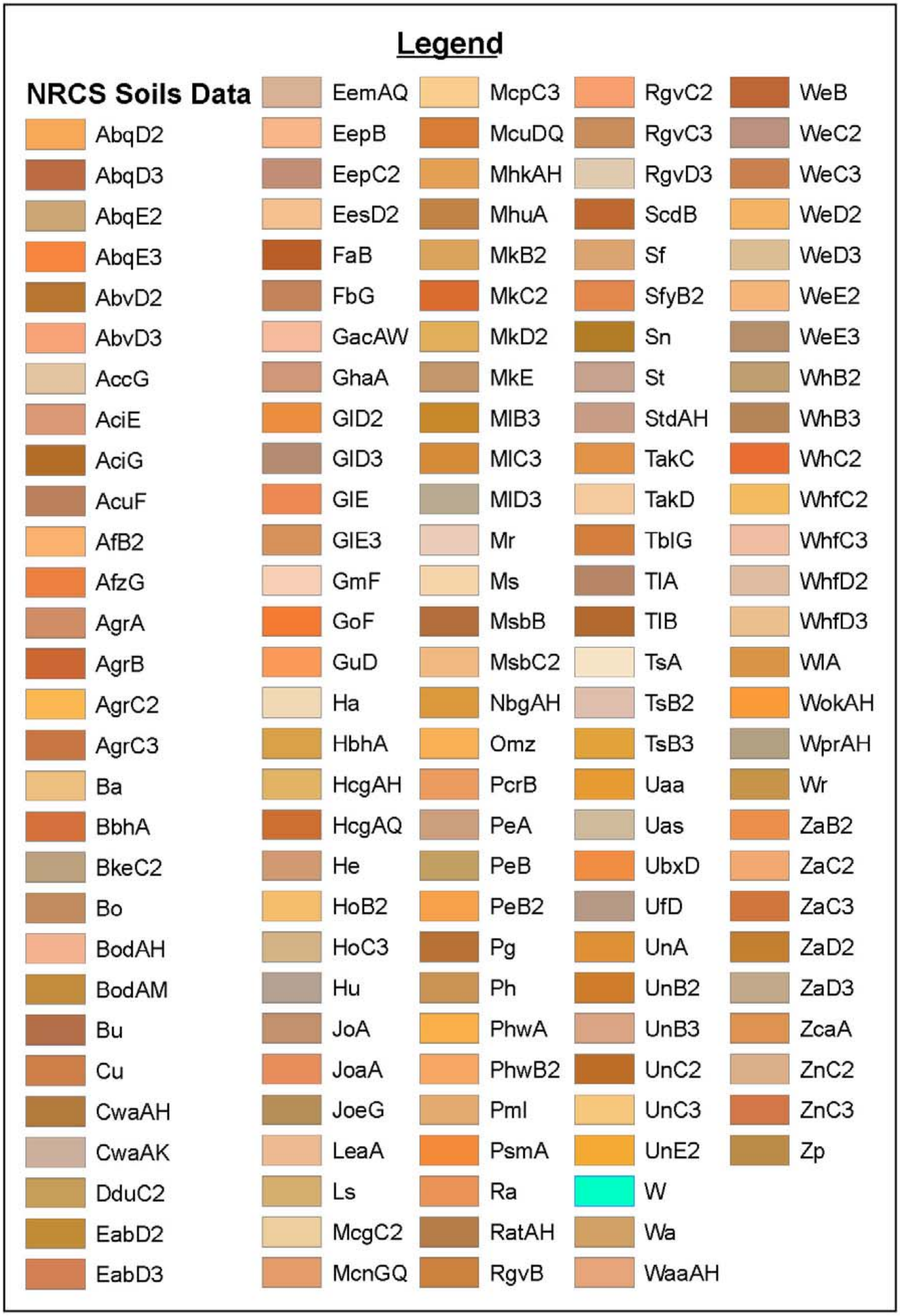
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NRCS Soils Data
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AcuF
AfB2
AfzG
AgrA
AgrB
AgrC2
AgrC3
Ba
BbhA
BkeC2
Bo
BodAH
BodAM
Bu
Cu
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CwaAK
DduC2
EabD2
EabD3
EemAQ
EepB
EepC2
EesD2
FaB
FbG
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GhaA
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HbhA
HcgAH
HcgAQ
He
HoB2
HoC3
Hu
JoA
JoaA
JoeG
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MhkAH
MhuA
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MkD2
MkE
MlB3
MlC3
MlD3
Mr
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MsbB
MsbC2
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Omz
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Ph
PhwA
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RatAH
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RgvC3
RgvD3
ScdB
Sf
SfyB2
Sn
St
StdAH
TakC
TakD
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TlB
TsA
TsB2
TsB3
Uaa
Uas
UbxD
UfD
UnA
UnB2
UnB3
UnC2
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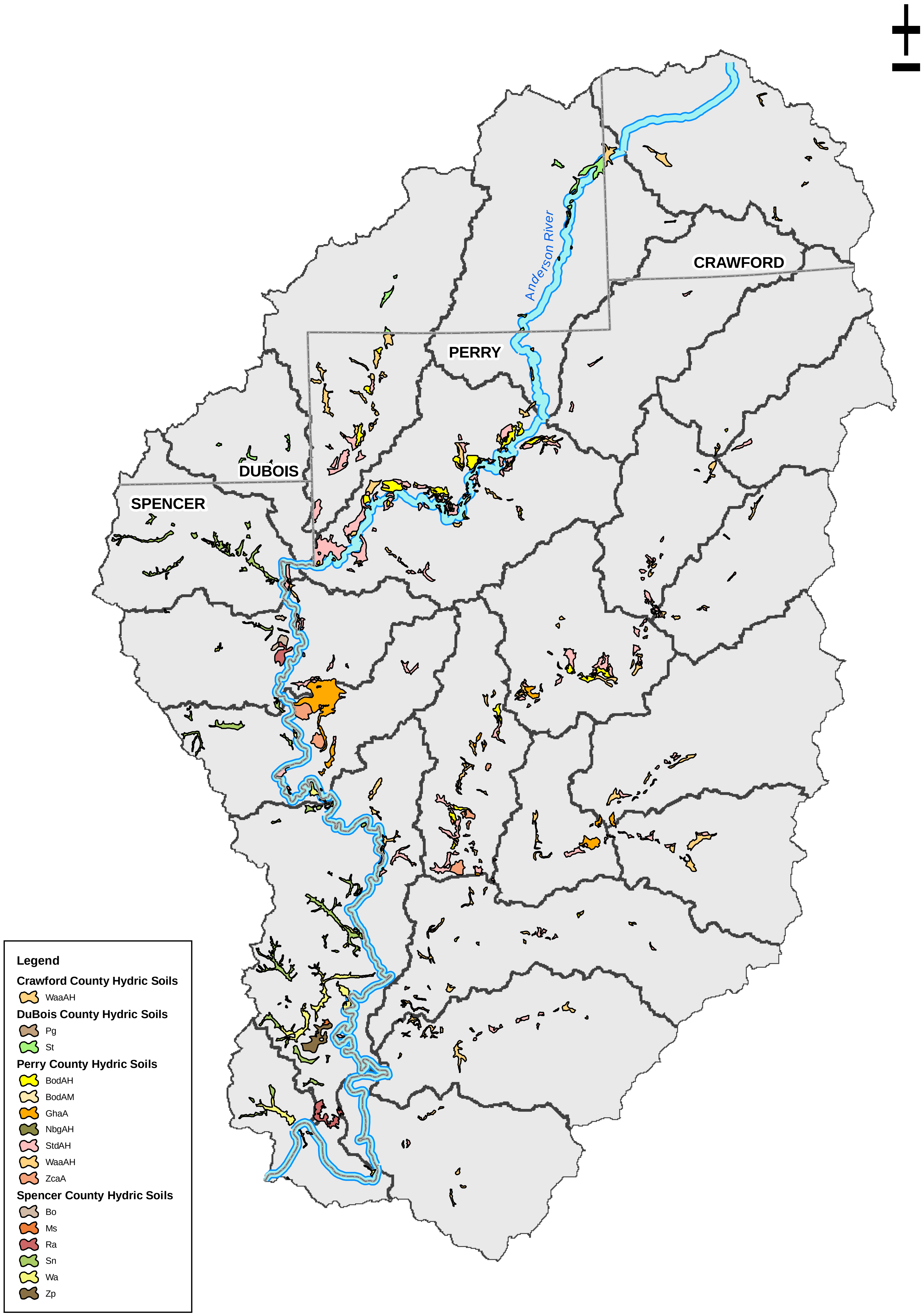

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: Hydric Soils Map	PROJECT: Anderson River Watershed Diagnostic Study		
BASE LAYER: NRCS	PROJECT NO.: 06002	EXHIBIT: VII	SHEET: 1 OF: 1
Client: Perry County Soil & Water Conservation District 125 S. Eighth Street, Room 6 Cannelton, Indiana 47520	FILE NAME: N/A	DATE: 12/13/06	SCALE: NTS

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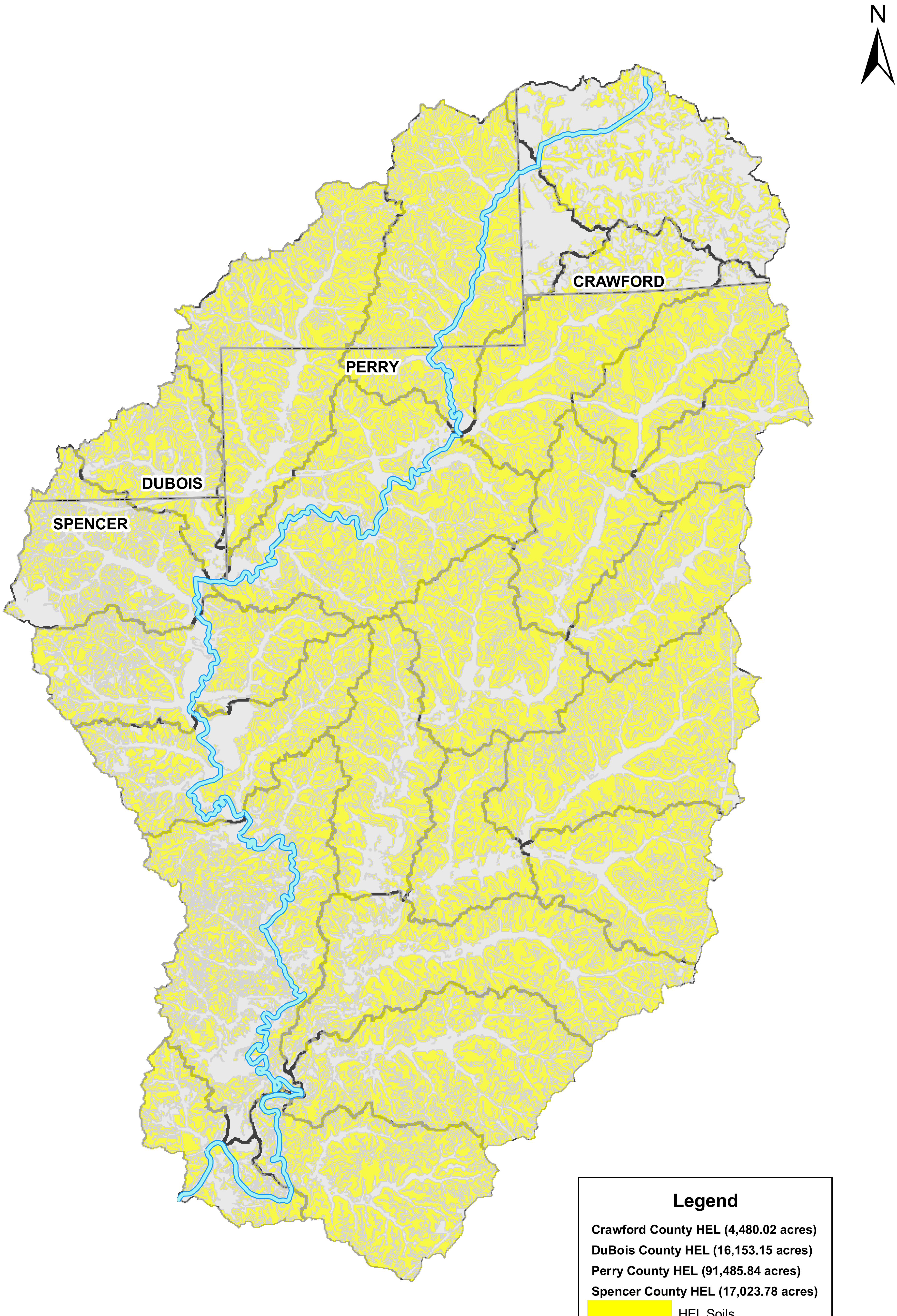
DRAFT - SUBJECT TO REVISION



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: Highly Erodible Lands (HEL) Map	PROJECT: Anderson River Watershed Diagnostic Study		
BASE LAYER: NRCS	PROJECT NO.: 06002	EXHIBIT: VIII	SHEET: 1 OF: 1
Client: Perry County Soil & Water Conservation District 125 S. Eighth Street, Room 6 Cannelton, Indiana 47520	FILE NAME: N/A	DATE: 12/13/06	SCALE: NTS

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3.3 Land use

The V3 delineated subwatersheds have land use distinctions that are much like the overall watershed, in that they are dominated by forested and agricultural uses, however, each subwatershed does provide local characteristics that directly relate to specific areas where watershed land use improvement practices can be implemented. The following discusses land use in the 25 subwatersheds, labeled with the station number and the waterways name. The stations are put in related groups and an overview for each group is given. The only characteristics evaluated are agriculture and forested area. Other land uses are given in Table 5. Some of these land uses, although not discussed in text, could be the cause of stream quality impacts even though they are only a small percentage of total area of their respective watershed. Station 22 (Blackhawk Creek) is the least forested station (17.86%) and has the largest percentage of pasture and cropland (80.81%). This station is near St. Meinrad and is located in the main stem Anderson River Watershed.

The next group has between thirty to fifty percent forest and fifty to seventy percent agriculture. Stations 6 (Kraus Creek), 20 (Ferdinand Run) and 24 (Swinging Creek) are included in this group. Stations 20 and 24 are located in the main stem Anderson and Station 6 is located in the Middle Fork Anderson Watershed.

Twelve stations are in the category of fifty to sixty-five percent forest and thirty-five to fifty percent agriculture and include Stations 1 (Anderson River), 2 Middle Fork Anderson River), 3 (Anderson River), 5 (Brushy Fork), 7 (Theis Creek), 8 (Sulphur Fork Creek), 9 (Little Sulphur Creek), 10 (Lanman Run), 11 (Sulphur Fork Creek), 13 (Middle Fork Anderson River), 21 (Ferdinand Run) and 23 (Anderson River). These are mostly located outside of Hoosier National Forest although Stations 9, 11 and 13 are within the National Forest.

Seven stations occur in the range of sixty-five to eighty percent forest and twenty to thirty-five percent agriculture. These stations include 4 (Middle Fork Anderson River), 14 (Middle Fork Anderson River), 15 (Sigler Creek), 16 (Anderson River), 17 (Anderson River), 18 (Mitchell Creek) and 19 (Hurricane Creek). These stations are located in the middle to upstream portions of the watershed.

Stations 12 (Winding Branch Creek) and 25 (Anderson River) are both in the greater than eighty percent forest and less than twenty percent agriculture. Station 12 has the most forested area in the study (92.76%). Both of these stations are located near headwaters and are in Hoosier National Forest.

A watershed land use description is located on Table 9. A map illustrating the land use is shown on Exhibit IX. See Appendix II for land use maps for each of the 25 V3 delineated subwatershed. In conclusion, the land use in the Anderson River watershed is largely forested and is mainly used for agriculture. Both uses combined account for 99.14% of the watershed.

TABLE 9 – LAND USE (Source: United States Geological Survey, 2002)

	Station 1		Station 2		Station 3		Station 4		Station 5	
	Anderson River		Middle Fork Anderson River		Anderson River		Middle Fork Anderson River		Brushy Fork	
Land Use	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**
Water	748.92	0.47%	540.90	0.80%	160.99	0.21%	319.44	1.26%	2.81	0.05%
Low Intensity Residential	154.85	0.10%	19.44	0.03%	121.36	0.16%	8.63	0.03%	5.40	0.09%
High Intensity Residential	3.35	<0.01%	0.25	<0.01%	2.65	<0.01%	0	0%	0	0%
Commercial, Industrial, Transportation	257.15	0.16%	168.83	0.25%	87.21	0.11%	88.73	0.35%	0.39	0.01%
Quarries, Strip Mines, Gravel Pits	78.06	0.05%	35.87	0.05%	41.46	0.05%	0	0%	0	0%
Deciduous Forest	83,071.78	51.18%	37,412.77	55.58%	38,245.43	50.23%	15,955.76	63.09%	2,981.54	50.84%
Evergreen Forest	6,493.22	4.00%	2,986.24	4.44%	3,226.49	4.24%	1,434.35	5.67%	80.11	1.37%
Mixed Forest	71.26	0.04%	35.94	0.05%	32.11	0.04%	17.38	0.07%	0.67	0.01%
Hay Pasture	37,911.91	23.36%	11,965.57	17.77%	20,193.75	26.52%	3,231.70	12.78%	1,603.29	27.34%
Row Crops	33,416.32	20.59%	14,107.64	20.96%	14,025.77	18.42%	4,320.40	17.08%	1,183.13	20.17%
Woody Wetlands	109.70	0.07%	39.48	0.06%	10.43	0.01%	8.55	0.03%	8.16	0.14%
Emergent Herbaceous Wetlands	6.29	<0.01%	5.63	0.01%	0.44	<0.01%	5.04	0.02%	0	0%
Total	162,323	100%	67,319	100%	76,146	100%	25,291	100%	5,865	100%

TABLE 9 – LAND USE (CONTINUED)

	Station 6		Station 7		Station 8		Station 9		Station 10	
	Kraus Creek		Theis Creek		Sulphur Fork Creek		Little Sulpher Creek		Lanman Run	
Land Use	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**
Water	1.70	0.03%	39.38	0.65%	173.23	0.97%	29.58	0.53%	1.29	0.05%
Low Intensity Residential	1.18	0.02%	1.03	0.02%	6.19	0.03%	0.97	0.02%	0	0%
High Intensity Residential	0	0%	0	0%	0.03	<0.01%	0	0%	0	0%
Commercial, Industrial, Transportation	5.47	0.09%	3.72	0.06%	70.90	0.40%	19.87	0.36%	0	0%
Deciduous Forest	3,074.84	48.03%	3,528.13	57.81%	9,741.18	54.46%	3,048.62	54.60%	1,508.79	55.98%
Evergreen Forest	30.96	0.48%	367.54	6.02%	980.10	5.48%	306.28	5.48%	211.67	7.85%
Mixed Forest	0.22	0%	0.95	0.02%	12.27	0.07%	5.14	0.09%	1.07	0.04%
Hay Pasture	1,741.72	27.21%	877.25	14.37%	3,270.17	18.28%	810.79	14.52%	657.38	24.39%
Row Crops	1,546.31	24.15%	1,284.55	21.05%	3,613.00	20.20%	1,349.71	24.17%	315.09	11.69%
Woody Wetlands	0	0%	0	0%	19.18	0.11%	12.42	0.22%	0	0%
Emergent Herbaceous Wetlands	0	0%	0.14	0%	0.22	<0.01%	0.22	<0.01%	0	0%
Total	6,402	100%	6,103	100%	17,887	100%	5,584	100%	2,695	100%

TABLE 9 – LAND USE (CONTINUED)

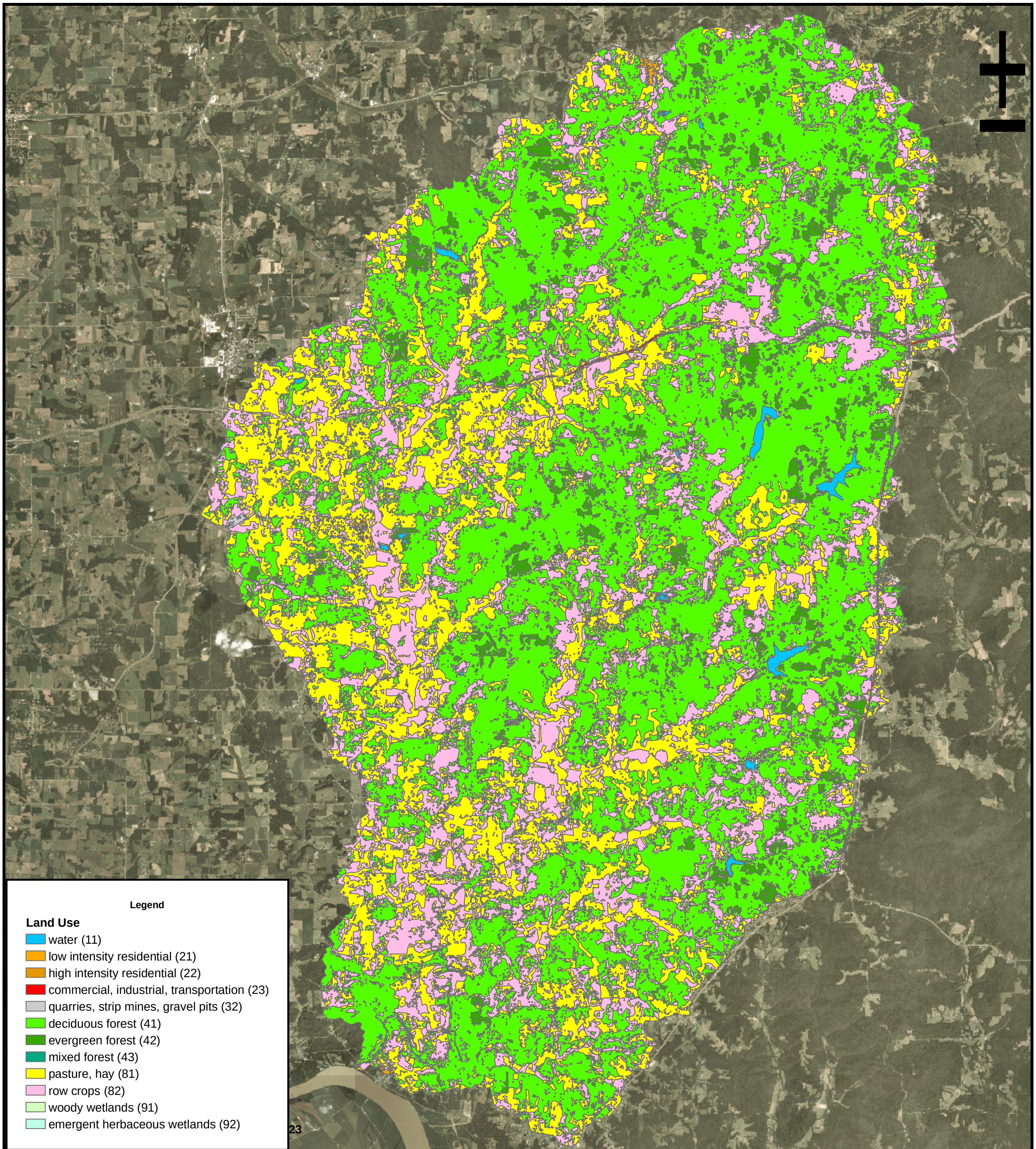
	Station 11		Station 12		Station 13		Station 14		Station 15	
	Sulphur Fork Creek		Winding Branch Creek		Middle Fork Anderson River		Middle Fork Anderson River		Sigler Creek	
Land Use	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**	**Area (acres)**	**Percent**
Water	1.48	0.05%	6.12	1.13%	3.35	0.04%	0	0%	3.57	0.05%
Low Intensity Residential	3.75	0.13%	0	0%	2.04	0.02%	0	0%	0.67	0.01%
High Intensity Residential	0.03	<0.01%	0	0%	0	0%	0	0%	0	0%
Commercial, Industrial, Transportation	36.63	1.30%	1.74	0.32%	66.00	0.73%	19.23	0.48%	20.82	0.28%
Deciduous Forest	1,555.08	55.36%	403.93	74.53%	5,391.86	59.54%	2,642.65	66.36%	4,768.38	63.38%
Evergreen Forest	149.73	5.33%	97.93	18.07%	486.44	5.37%	150.42	3.78%	462.44	6.15%
Mixed Forest	0.65	0.02%	0.87	0.16%	7.87	0.09%	5.21	0.13%	6.20	0.08%
Hay Pasture	548.33	19.52%	8.78	1.62%	1,135.42	12.54%	503.85	12.65%	876.52	11.65%
Row Crops	512.87	18.26%	23.64	4.36%	1,962.60	21.67%	660.33	16.58%	1,384.24	18.40%
Woody Wetlands	0.87	0.03%	0	0%	0	0%	0	0%	0	0%
Emergent Herbaceous Wetlands	0	0%	0	0%	0.27	<0.01%	0	0%	0	0%
Total	2,809	100%	542	100%	9,056	100%	3,982	100%	7,523	100%

TABLE 9 – LAND USE (CONTINUED)

Land Use	Station 16 Anderson River		Station 17 Anderson River		Station 18 Mitchell Creek		Station 19 Hurricane Creek		Station 20 Ferdinand Run	
	Area (acres)	Percent	Area (acres)	Percent	Area (acres)	Percent	Area (acres)	Percent	Area (acres)	Percent
Water	26.94	0.14%	20.19	0.16%	0.46	0.01%	53.92	0.52%	16.84	0.48%
Low Intensity Residential	65.15	0.35%	65.15	0.50%	0	0%	1.03	0.01%	0.44	0.01%
High Intensity Residential	0.57	<0.01%	0.57	<0.01%	0	0%	0.22	<0.01%	0	0%
Commercial, Industrial, Transportation	1.66	0.01%	1.66	0.01%	0	0%	3.33	0.03%	3.41	0.10%
Deciduous Forest	12,608.41	67.66%	8,577.47	66.27%	3,565.08	66.55%	6,108.22	59.22%	1,186.91	33.79%
Evergreen Forest	1,135.29	6.09%	936.16	7.23%	427.18	7.97%	689.10	6.68%	86.99	2.48%
Mixed Forest	7.13	0.04%	5.53	0.04%	2.23	0.04%	6.66	0.06%	0.36	0.01%
Hay Pasture	2,166.86	11.63%	1,419.47	10.97%	527.09	9.84%	2,219.82	21.52%	1,289.54	36.71%
Row Crops	2,621.88	14.07%	1,916.20	14.80%	834.77	15.58%	1,231.16	11.94%	928.84	26.44%
Woody Wetlands	0.86	<0.01%	0.86	0.01%	0.45	0.01%	0.45	<0.01%	0	0%
Emergent Herbaceous Wetlands	0	0%	0	0%	0	0%	0	0%	0	0%
Total	18,635	100%	12,943	100%	5,357	100%	10,314	100%	3,513	100%

TABLE 9 – LAND USE (CONTINUED)

Land Use	Station 21 Ferdinand Run Area (acres)	Station 21 Ferdinand Run Percent	Station 22 Blackhawk Creek Area (acres)	Station 22 Blackhawk Creek Percent	Station 23 Anderson River Area (acres)	Station 23 Anderson River Percent	Station 24 Swinging Creek Area (acres)	Station 24 Swinging Creek Percent	Station 25 Anderson River Area (acres)	Station 25 Anderson River Percent
Water	72.32	0.49%	3.91	0.07%	116.19	0.21%	1.23	0.03%	1.04	0.03%
Low Intensity Residential	1.48	0.01%	25.18	0.44%	68.62	0.13%	13.18	0.37%	0.12	<0.01%
High Intensity Residential	0.22	<0.01%	0.36	0.01%	0.80	<0.01%	0	0%	0	0%
Commercial, Industrial, Transportation	6.74	0.05%	5.45	0.09%	68.71	0.13%	0	0%	0	0%
Quarries, Strip Mines, Gravel Pits	0	0%	41.46	0.72%	0	0%	0	0%	0	0%
Deciduous Forest	7,473.21	51.02%	1,020.89	17.70%	31,321.67	57.32%	1,589.66	44.62%	2,453.71	74.35%
Evergreen Forest	776.59	5.30%	8.24	0.14%	2,788.07	5.10%	126.05	3.54%	311.63	9.44%
Mixed Forest	7.25	0.05%	1.11	0.02%	26.30	0.05%	1.61	0.05%	1.61	0.05%
Hay Pasture	3,821.46	26.09%	3,161.55	54.80%	11,188.57	20.48%	1,319.68	37.04%	179.81	5.45%
Row Crops	2,487.55	16.98%	1,500.69	26.01%	9,055.11	16.57%	511.27	14.35%	352.48	10.68%
Woody Wetlands	0.44	<0.01%	0	0%	4.94	0.01%	0	0%	0	0%
Emergent Herbaceous Wetlands	0	0%	0	0%	0	0%	0.44	0.01%	0	0%
Total	14,647	100%	5,769	100%	54,639	100%	3,563	100%	3,300	100%



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE:	**Land Use Map Overall Watershed**
PROJECT:	**Anderson River Watershed Diagnostic Study**
BASE LAYER:	N/A
PROJECT NO.	06002
EXHIBIT:	IX
SHEET:	1
OF:	1
CLIENT:	Perry County Soil & Water Conservation District, 125 S. Eighth Street, Room 6, Cannelton, Indiana 47520
QUADRANGLE:	N/A
DATE:	1/24/07
SCALE:	NTS

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3.4 Wetlands, Floodplain and Riparian Zones

The study watershed, which consists of 164,610 acres, has approximately 1,863 acres of wetlands (or 1% of the watershed area) and has approximately 15,450 acres within the 100-year floodplain. There are 542 acres of lacustrine wetlands, 1,245 acres of palustrine wetlands and 76 acres of riverine wetlands within the Anderson River Watershed (see Exhibit XI). Wetlands provide numerous valuable functions that are necessary for watershed health. Paramount of these functions is the improvement of water quality, which is accomplished by the stabilizing and filtering functions provided by the dense wetland vegetation. Wetland vegetation adjacent to the streambanks provide stabilization of slopes and prevent mass wasting, thus reducing the sediment load within the river system. An unprotected streambank can easily erode, which results in an increase of sediment and nutrients entering the water. Additionally, wetland vegetation removes pollutants through the natural filtration that occurs, or by absorption and assimilation. This effective treatment of nutrients and physical stabilization leads to an increase in overall water quality to downstream reaches.

Because wetlands possess soil that has a high amount of pore space and usually is organic, wetlands can also provide temporary storage of rainwater, thereby protecting downstream areas. This stormwater attenuation provided by wetlands reduces peak flows on the river system, which reduces downstream flooding and erosion. Some wetlands also recharge groundwater, which allows water to seep slowly and replenish an underlying aquifer. This groundwater recharge also is valuable to wildlife during the summer months when precipitation is low and the baseflow of the river draws on the surrounding groundwater table.

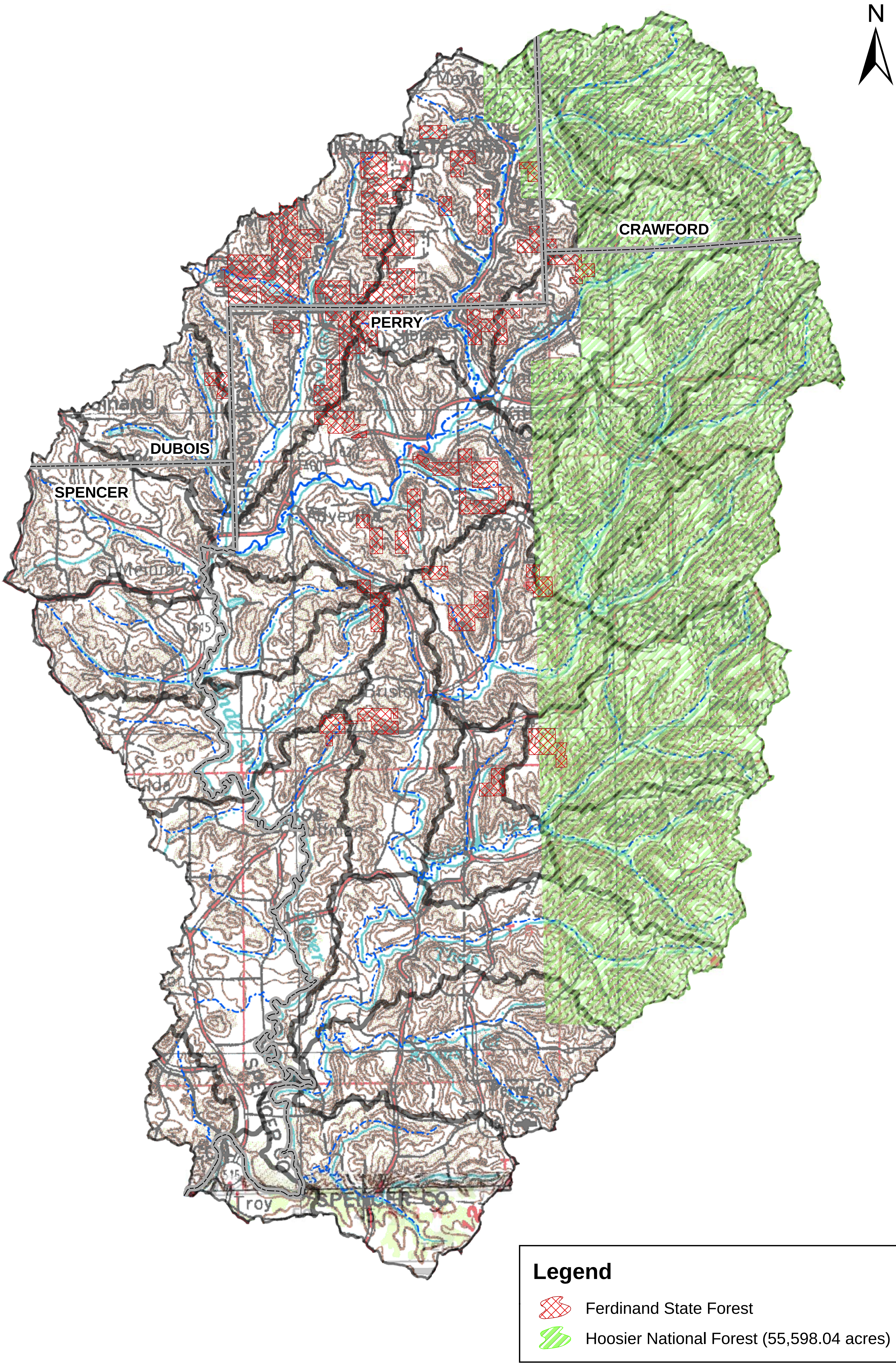
As a small component of the natural landscape, wetlands contain an unusually large percentage of wildlife and produce more living things per acre than other ecosystems. As a result of this high diversity, wetlands provide enormous recreational opportunities, such as fishing, boating, hiking and bird watching.

Hydric soils denote areas that would support wetlands with the appropriate hydrology. It is typical for agricultural drainage tiles to be placed in areas of hydric soils so that land could be drained and rowcropped. Hydric soils consist of 2.9% of the entire Anderson River watershed. Crawford County has 102 acres of hydric soils within the watershed, Dubois County has 221 acres, Perry County has 3,224 acres and Spencer County has 1,182 acres. These may be similar to the locations of historically functional wetlands.

3.5 Significant Natural Areas

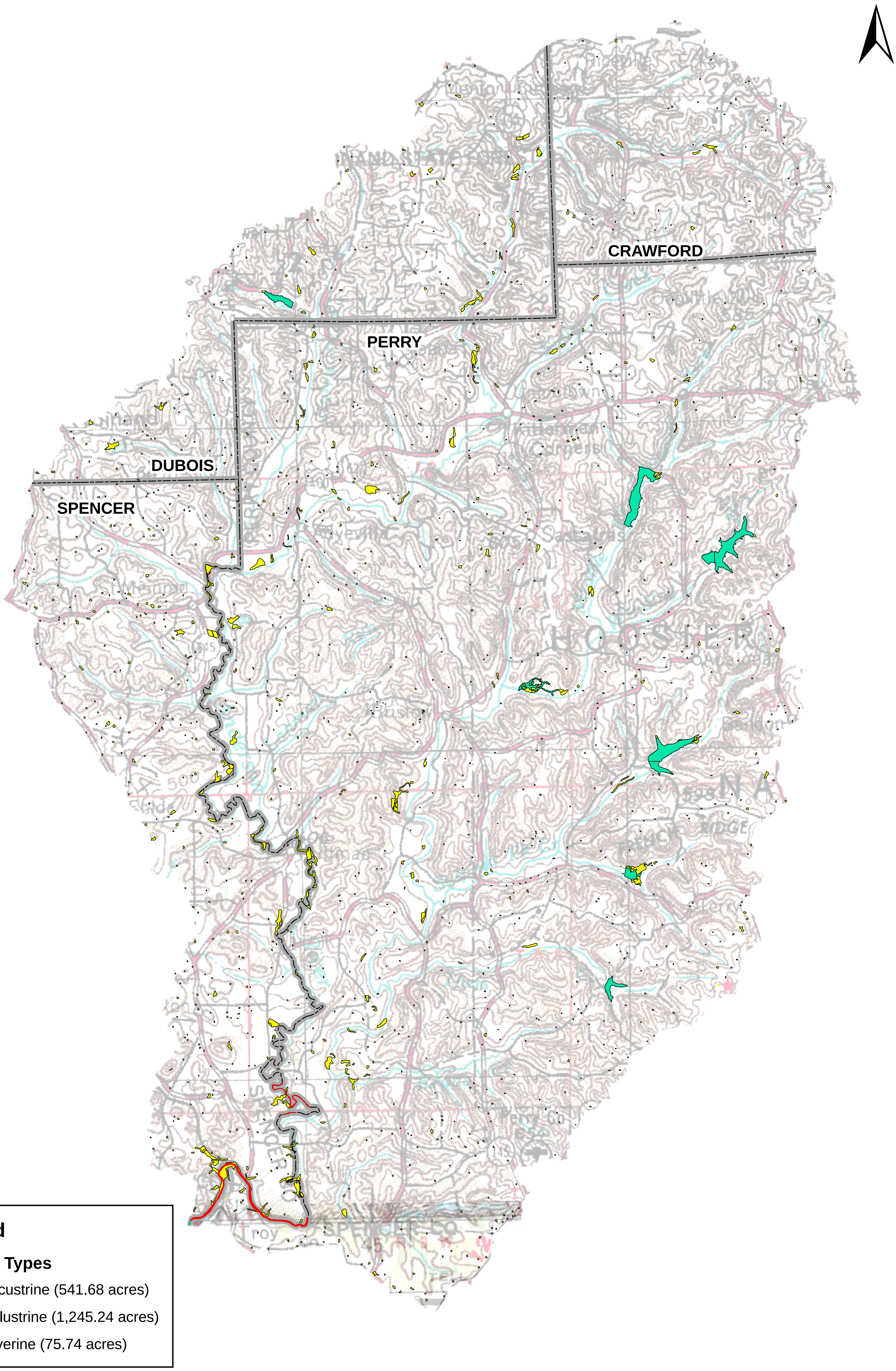
Approximately one-third of the Anderson River watershed is located in the Hoosier National Forest, also discussed in Section 1.6 Unique Recreational Resources (see Exhibit X). Pre-1935, much of the National Forest was commercially logged. The U.S. Forest Service began buying land in early 1935 and this continued for several decades. This land was planted with trees by the Civilian Conservation Corp (CCC) Program to provide jobs during the Great Depression. The goal of this project was to stop the massive erosion problems that were occurring in the area. Seventy years later this area is teaming with diversity and is the only National Forest in the state of Indiana.

Ferdinand State Forest (see Section 1.6) consists of 7,657 acres. The creation of this state forest started as a 900 acre piece of land bought by a local conservation club in 1933 for hunting and fishing. The following year it was agreed that the Indiana Department of Conservation would take care of the land and it turned into a State Forest. This area provides significant forested habitat and also several lakes.



V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: Hoosier National Forest within the Anderson River Watershed	PROJECT: Anderson River Watershed Diagnostic Study	
	BASE LAYER: Street Map USA and USGS Topographic Map	PROJECT NO.: 06002	EXHIBIT: X	SHEET: 1 OF: 1
	Client: Perry County Soil & Water Conservation District, 125 S. Eighth Street, Room 6, Cannelton, Indiana 47520	FILE NAME: N/A	DATE: 12/13/06	SCALE: NTS

F:\2006\06002\Reports\Natural Resources\Wetland\Exhibits\Main Exhibits\Exhibits For Tim\Exhibit X Hoosier National Forest Boundary Map.mxd



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: National Wetland Inventory Map	PROJECT: Anderson River Watershed Diagnostic Study		
BASE LAYER: USGS Topographic Map	PROJECT NO.: 06002	EXHIBIT: XI	SHEET: 1 OF: 1
Client: Perry County Soil & Water Conservation District, 125 S. Eighth Street, Room 6, Cannelton, Indiana 47520	FILE NAME: N/A	DATE: 12/13/06	SCALE: NTS

E:\2006\06002\Reports\Natural Resources\Wetland\Exhibits\Main Exhibits\Exhibits For Tim\Exhibit XI NWI and Topo Map.mxd

3.6 Threatened and Endangered Species

The U.S. Fish and Wildlife Service (USFWS) was contacted to provide records of any federally listed threatened or endangered species or natural areas that occur within the Anderson River Watershed. Their response provided information on two federally endangered mammals and one federally threatened bird that have ranges overlapping with the watershed. These include both the endangered Indiana bat (*Myotis sodalis*) and gray bat (*Myotis grisescens*), as well as the threatened bald eagle (*Haliaeetus leucocephalus*).

Additionally, the IDNR was also contacted to provide any Indiana Natural Heritage Data or related records for any listed threatened, endangered or rare species, high quality natural communities or natural areas documented within the Anderson River Watershed. Their response provided information on six bird, three insect, two mammal, and nine vascular plant species.

Six bird species were listed as state species of special concern (SSC): red-shouldered hawk (*Buteo lineatus*), broad-winged hawk (*Buteo platypterus*), Cerulean warbler (*Dendroica cerulea*), worm-eating warbler (*Helmitheros vermivorus*), black-and-white warbler (*Mniotilta varia*) and hooded warbler (*Wilsonia citrina*).

Various listings existed for three different species of protected insects. The one species that was listed as state endangered (SE) was the cocoa clubtail (*Gomphus hybridus*). Two species were listed as state rare (SR): lace-winged roadside-skipper (*Amblyscirtes aesculapius*) and gemmed satyr (*Cyllopsis gemma*).

Two mammal species were listed. The one species that was listed as federal endangered (LE) and state endangered (SE) was the gray bat (*Myotis grisescens*). One specie was not ranked but is being tracked to monitor the status, which was the bobcat (*Lynx rufus*).

Various listings existed for nine different species of vascular plants. Three species were listed as state endangered (SE): bluehearts (*Buchnera americana*), bristly foxtail (*Setaria geniculata*) and white crownbeard (*Verbesina virginica*). One species was listed as state threatened (ST): white thoroughwort (*Eupatorium album*). One species was listed as state extirpated (SX): deam dewberry (*Rubus deamii*). Two species were listed on the watch list (WL): orange coneflower (*Rudbeckia fulgida* var. *fulgida*) and grassleaf ladies'-tresses (*Spiranthes vernalis*). Two species were listed as state rare (SR): longbeak arrowhead (*Sagittaria australis*) and netted chainfern (*Woodwardia areolata*).

The response letters to these inquiries are provided within Appendix III.

4.0 COLLECTION AND ANALYSIS OF BIOLOGICAL, HABITAT AND WATER QUALITY INFORMATION

4.1 Evaluation Methods

Macroinvertebrate monitoring followed the USEPA's Benthic Macroinvertebrate Protocol for the multihabitat approach. The multihabitat approach involves the systematic collection of benthic macroinvertebrates from all available instream habitats by kicking the substrate or jabbing with a dip net. A total of 20 jabs or kicks are taken from all major habitat types in the reach resulting in sampling approximately 3.1 m^2 of habitat. The collected organisms are sorted in the V3 laboratory and identified to the lowest practical taxon using publications and keys indicated in section 6.0 which include: Bednarik & McCafferty 1979, Bergman & Hilsenhoff 1978, Hilsenhoff 1982, Hilsenhoff 1995, McCafferty & Waltz 1990, Merritt & Cummins 1996 and Schuster & Etnier 1978. The collection procedure provides representative macroinvertebrate fauna from all of the available instream habitats including riffle and run habitat types that provide representatives of scraper and filterer functional feeding groups, and Course Particulate Organic Matter (CPOM) such as detritus, leaves, needles, twigs, sticks, bark and other fragments that provide representatives of the shredder functional feeding group. Sources of CPOM include leaf packs, shorezones and other depositional areas.

Habitat evaluation followed the Ohio EPA Qualitative Habitat Evaluation Index (QHEI) habitat assessment approach, as directed by IDNR LARE program staff. Habitat incorporates all aspects of physical and chemical constituents along with the biotic interactions. Habitat includes all of the instream and riparian habitat that influences the structure and function of the aquatic community in a stream. The presence of an altered habitat structure is considered one of the major stressors of aquatic systems. The purpose for evaluating the physical habitat features of the selected locations within the Anderson River Watershed is to quantify the condition and quality of the instream and riparian habitat. The QHEI habitat assessment approach was developed to describe the overall quality of the physical habitat.

Water quality analysis was measured in the field using an YSI Model 63 Handheld pH, Conductivity, Salinity and Temperature System, YSI Model 50B Dissolved Oxygen Meter, LaMotte 2020 Turbidimeter, and MARSH-McBIRNEY FLO-MATE Model 2000 Portable Flowmeter. V3 performed the water quality measurements for the following parameters: temperature, conductivity, specific conductance, salinity, pH, dissolved oxygen, flow, and turbidity. V3 also collected water samples for water chemistry analysis at Environmental Consultants Inc. of Clarksville, Indiana for the following parameters: Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Dissolved Phosphorous, Total Phosphorous, and *Escherichia Coliform (E. coli).*

4.2 Biological Evaluation Explanation

An explanation of key benthic macroinvertebrate evaluations is summarized below:

Richness measures
Total number of distinct taxa is a measure of the diversity within the sample. This value generally increases with increasing water quality, habitat diversity and habitat suitability.

Total number of EPT taxa summarizes the richness of the benthic macroinvertebrate community within the taxa groups that are generally considered pollution sensitive and will generally increase with increasing water quality. This metric is the total number of distinct taxa within the groups Ephemeroptera (mayfly), Plecoptera (stonefly) and Tricoptera (caddisfly).

Composition measures
Percent Contribution of Dominant Taxa uses the abundance of the numerically dominant taxon relative to the total number of organisms as an indication of community balance. This value will decrease as water quality, habitat diversity and habitat suitability improve.

The ratio of EPT (mayflies, stoneflies and caddisflies) and Chironomidae (midges) reflects good biotic condition if the sensitive groups (EPT's) demonstrate a substantial representation. If the Chironomidae have a disproportionately large number of individuals in comparison to the sensitive groups then this situation is indicative of environmental stress.

Tolerance/Intolerance measures
Tolerance/intolerance measures are intended to be representative of relative sensitivity to perturbation. Tolerance is generally non-specific to the type of stressor. However, metrics such as the Hilsenhoff Biotic Index are oriented toward the detection of organic pollution.

The Modified Biotic Index (MBI) was developed to detect organic pollution and is based on the original species level index developed by Hilsenhoff in 1982. Pollution tolerance values range from 0 to 10 and increase as water quality decreases. The lower the MBI, the greater the number of pollution intolerant species. A population of benthic macroinvertebrates that poses a lower MBI value is indicative of higher water quality.

Functional Feeding Group Measures
The ratio of scraper to filtering collector reflects the riffle/run community food base. The relative abundance of scrapers and filtering collectors in the riffle/run habitat is indicative of periphyton community composition, availability of fine particulate organic material and the availability of attachment sites for filtering. Scrapers increase with an increase in diatom abundance and decrease in filamentous algae and aquatic mosses. Filamentous algae and aquatic mosses provide good attachment sites for filtering collectors and the organic enrichment often responsible for filamentous algae growth can also provide fine particulate organic material that is utilized by filtering collectors. Filtering collectors are also sensitive to toxicants bound to fine particles and should be the first group to decrease when exposed to steady sources of such bound

toxicants. Lower numbers would indicate higher water quality, however, USEPA provides higher numbers with a higher Biological Condition Score (USEPA 1989).

Sampling the Coarse Particulate Organic Matter (CPOM) component requires a composite collection of various plant parts such as leaves, needles, twigs, bark or their fragments. Sources for the CPOM sample include leaf packs, shorezones and other depositional areas.

Ratio of Shredder functional feeding group relative to the abundance of all other functional feeding groups allows for the evaluation of potential impairment. Shredders are sensitive to riparian zone impacts and are particularly good indicators of toxic effects when the toxicants involved are readily adsorbed to the CPOM and either affect microbial communities colonizing the CPOM or the shredders directly (USEPA 1989).

Community Similarity Indices
The Jaccard Coefficient of Community measures the degree of similarity in taxonomic composition between two stations in terms of taxon presence or absence and has the ability to discriminate between highly similar collections.

Community Loss Index measures the loss of benthic species between a reference station and the station of comparison. The lower the number, the higher the similarity to the reference station and the better projection for higher water quality.

4.3 Habitat Evaluation Explanation

The maximum is a score that can be obtained using the Ohio EPA QHEI is a value of 100. The maximum points possible for each of the habitat parameters are as follows: Substrate = 20, Instream Cover = 20, Channel Morphology = 20, Riparian Zone and Bank Erosion = 10, Pool/Glide Quality = 12, Riffle/Run Quality = 18.

4.4 Water Quality Evaluation Explanation

An explanation of key water quality parameters is summarized below:

<u>Phosphorus.</u> Phosphorus is a major cellular component of organisms. Phosphorus can be found in its dissolved and sediment-bound forms. However, phosphorus is often locked up in living biota, primarily algae. In the watershed, phosphorus is found in fertilizers and in human and animal wastes. The availability of phosphorus determines the growth and production of algae and makes it the limiting nutrient in the system. In this study, water samples were analyzed for dissolved and total phosphorus. Dissolved phosphorus is important because it is readily usable by algae. Total phosphorus values are important because concentrations greater than 0.03 mg/L (30μg/L) can cause algal blooms.

Nitrogen. Nitrogen is another major cellular component of organisms. Nitrogen can enter water bodies from the air and as inorganic nitrogen and ammonia for use by bacteria, algae and larger plants. The four common forms of nitrogen are:

- Ammonia (NH_4) – is present naturally in surface waters. Bacteria produce ammonia as they decompose dead plant and animal matter. The concentration of ammonia is generally low in groundwater because it adheres to soil particles and clays and does not leach readily from soils.
- Organic nitrogen – (*TKN*) is defined functionally as organically bound nitrogen in the trinegative oxidation state. Organic nitrogen includes nitrogen found in plants and animal materials, which includes such natural materials as proteins and peptides, nucleic acids and urea. In the analytical procedures, Total Kjeldahl Nitrogen (*TKN*) determines both organic nitrogen and ammonia. Raw sewage will typically contain more than 20 mg/L.
- Nitrite (NO_2) – is an intermediate oxidation state of nitrogen, both in the oxidation of ammonia to nitrate and in the reduction of nitrate.
- Nitrate (NO_3) – Nitrate generally occurs in trace quantities in surface water but may attain high levels in some groundwater. In excessive amount, it contributes to the illness know as methemoglobinemia in infants. A limit of 10 mg/L has been imposed on drinking water to prevent this disorder. Monitoring of residents groundwater drinking wells is recommended in areas where surface water nitrate levels exceed this limit, in the event that the nitrate levels are infiltrating the groundwater aquifer.

Bacteria, Fecal Coliform and *E. coli*. *E. coli* is a member of the fecal coliform group of bacteria. When this organism is detected within water samples, it is an indication of fecal contamination. *E coli* is an indigenous fecal flora of warm-blooded animals. Contributions of detectable *E coli* colonies may appear within water samples due to the input from human or animal waste. Common sources of animal waste are agricultural feedlots (pigs, cattle, etc…), pet waste (such as dogs) or bird waste (such as Canada geese or seagulls). Rain storm events or snow melts frequently wash waste and the associated *E coli* into surface water systems. The state standard in Indiana for *E coli* is 235 cfu/100mL. The measure of cfu per 100 mL means the count of colony forming units that exist in 100 milliliters of water.

Temperature. The ecological effects of light and temperature on the photosynthesis and growth of algae are inseparable because of the interrelationships in metabolism and light saturation. One commonly observed change in the rate of respiration of planktonic algae is an increase of the rate with increasing temperature. Additionally, the ability of water to hold oxygen decreases as temperatures increase. When water is oxygen saturated, warmer water has the ability to possess lower amounts of oxygen when compared to colder water that is likewise oxygen saturated.

Conductivity. The conductance of water is the reciprocal of its resistance to electrical flow. The resistance of a water solution to electrical current or electron flow is reduced with increasing content of ionized salt. Distilled water has a conductivity of zero. The purer the water is, the lower its conductivity.

Specific Conductance. Specific Conductance is the conductance at 25ºC. This reading is important because conductivity readings are directly linked to temperature and can change up to 3% for a change of one degree Celsius.

Salinity. Salinity is a measure of the total salts that are dissolved in water, in parts per thousand (ppt). Salinity will be variable from location and time of year. Plants are adversely affected by high salinity, which can cause stunted growth, leaf burn and defoliation. The ocean's salinity is approximately 35 ppt. The following list denotes various concentration levels of salinity in natural environments, however, urban influences of salt distribution during wintertime provides a non-natural situation:

- Fresh water, 0 ppt, no tidal influence
- Tidal Fresh, 0 – 1 ppt, tidal influence
- Oligohaline, 2 – 5 ppt, slightly brackish
- Mesohaline, 8 – 15 ppt, brackish
- Polyhaline, >18 ppt, salt water

The most commonly used road salt is sodium chloride (NaCl). NaCl dissociates in aquatic systems into chloride ions (Cl^-) and sodium cations (Na^+). This also results in a higher conductivity reading. Elevated sodium and chloride levels create osmotic imbalances in plants, which inhibit water absorption and reduce root growth. Various species of fish, amphibians and aquatic macroinvertebrates are adversely impacted by increased levels of sodium and chloride.

pH (Acidic and Alkaline). The pH of a water body reflects the concentration of hydroxide (OH^-) in the water body. A low pH signifies an acidic medium (lethal effects of most acids begin to appear at pH = 4.5) while a high pH signifies an alkaline medium (lethal effects of most alkalis begin to appear at pH = 9.5). Neutral pH is 7. The actual pH of a water sample indicates the buffering capacity of that water body.

Dissolved Oxygen. Dissolved oxygen is the gaseous form of oxygen and is essential for respiration of aquatic organisms (i.e. fish and plant). Dissolved oxygen enters water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. Oxygen saturation in water would equal 100% if equilibrium were reached. Values greater than 100% saturation indicate photosynthetic activity within the water. Large amounts of dissolved oxygen in the water indicate excessive algae growth. Dissolved oxygen is consumed by respiration of aquatic organisms and during bacterial decomposition of plant and animal matter.

Turbidity. The waters transparency can be affected by two primary factors: algae and suspended particulate matter. An increase in the density of the phytoplankton or suspended particles signifies an increase in the waters turbidity.

4.5 Biological Evaluation Results

V3 sent 54 voucher specimens to Purdue University, Department of Entomology of macroinvertebrates to be verified by Dr. Arwin Provonsha. Dr. Provonsha's response letter confirming correct identification for all vouchered macroinvertebrates, V3 letter and photo documentation of the specimens are all contained in Appendix IV. These specimens were collected during the 2006 study. Benthic aquatic macroinvertebrates were not able to collected from all of the sampling stations as physical conditions, such as water depth, were not favorable to the sampling methods. The biological impairment at these stations are unknown as this evaluation matrix could not be quantified. Table 10 lists the macroinvertebrates that were collected during the September 2006 sampling event at each of the nineteen stations. Table 11 lists general data for the USEPA evaluation metric by sampling station.

TABLE 10 – BENTHIC MACROINVERTEBRATE COLLECTED BY STATION, SEPTEMBER 2006

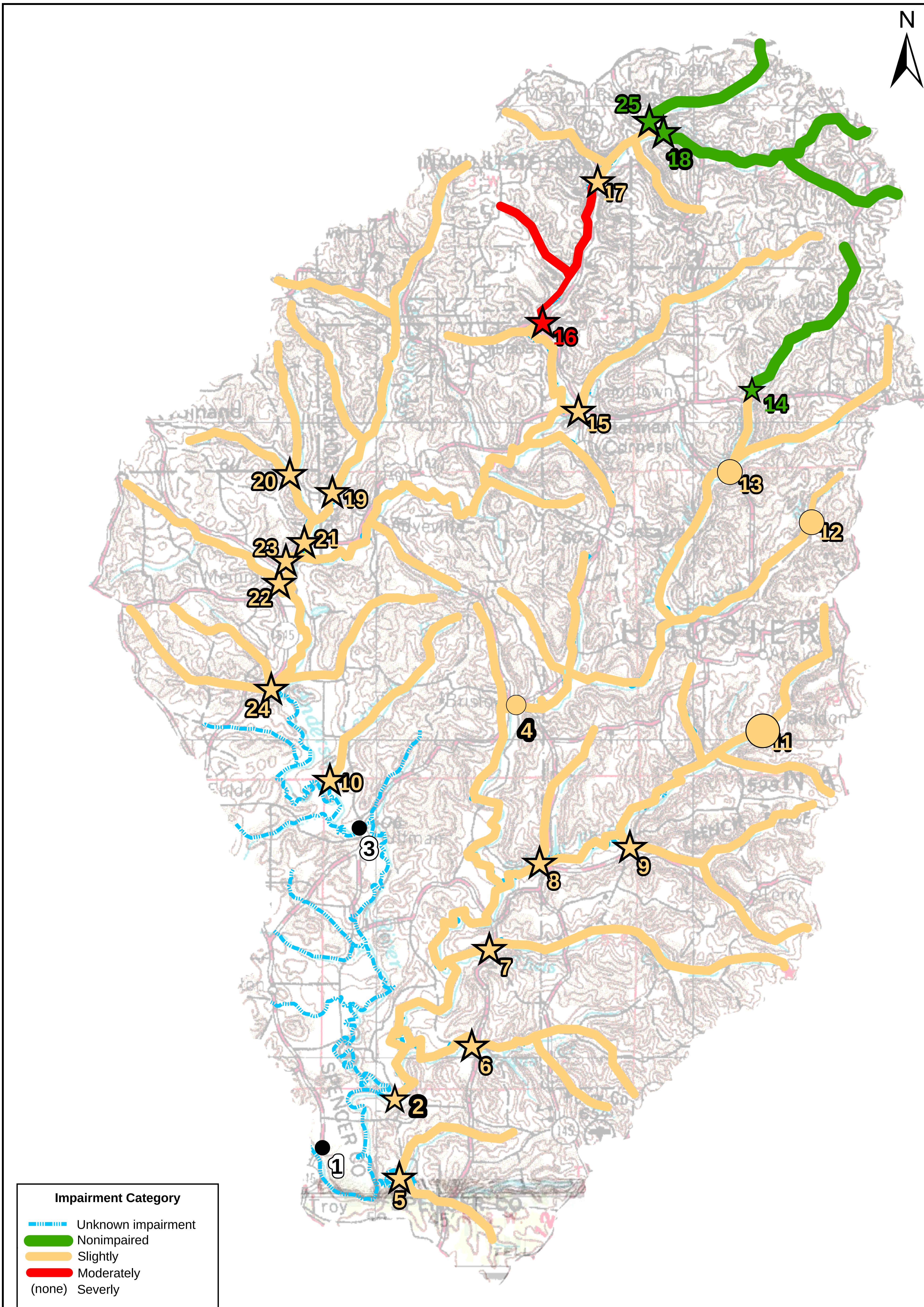
ORDER	FAMILY	GENUS	SPECIES	2	5	6	7	8	9	10	14	15	16	17	18	19	20	21	22	23	24	25
Nematomorpha																						1
Hydracarina-Trombidiformes							1							3						1		
Tubellaria	Planaria			1			2		1							1	7					
Pelecypoda	Corbiculidae	Corbicula	Fluminea	2		5	11	9	1			1	43					7		1		
	Sphaeriidae							1														
Gastropoda	Ancylidae										5											
	Lymnaeidae			11			1	1				1	1	2								
	Physidae			3		4	1	8		4	1	1	2	1								
	Planorbidae											1	2					1				
	Viviparidae						5															
Annelida	Oligochaeta					3	1		1		2		4	1	1	7	1	1		2	1	
	Hirudinea																	1		1		
Decapoda	Cambaridae			3		3	1		1		2	3	8	3	5	1	1	3	1	2		7
	Papaemonidae			1			5	5	3													
Amphipoda	Talitridae	Hyalella	Azteca	1	2				1	1	3	2		6			1					1
Isopoda	Asellidae														1					6	1	3
Ephemeroptera	Caenidae	Caenis				12			1	9		1		5	2	4	3	4		9	16	
	Baetidae			3	4	17		4	2	18	3	1		3	1	7	16	10	35	3	4	
	Heptageniidae	Stenacron		17	1			3	12	2	2							5				
	Heptageniidae	Stenonema				12	1			8	20	8	2	5	31	9	5	5	18	6	13	9
	Leptophlebiidae	Leptophlebia										1					2					
Coleoptera	Gyrinidae	Dineutus						1				2					1	4				
	Haliplidae	Peltodytes		1			1					2	2	1								
	Noteridae							5	1	1	3				5	8					1	2
	Dryopidae				3	4		8	7	1		7	12	8	6		6	5	1		2	4
	Elmidae			15	4	3	2	9		5			3			5	2				2	1
	Psephenidae	Psephenus							1		11	2			12							29
	Hydrophiloidae									1		1		1		1					1	
	Hydrophiloidae	Tropisternus				2		3	1	1	3											1
Lepidoptera	Pyralidae	Crambus					1															

Megaloptera	Corydalidae	Nigronia									1											
	Sialidae	Sialis		1						1	1		2	6	1		1			2		
Trichoptera	Hydropsychidae			25	46	3		24	4	12	4			1	2	8	10	3	22	1	8	5
	Philopotamidae				5	3	1	3	1	1						1	22		11			1
	Rhyacophilidae	Rhyacophila													3							4
Hemiptera	Belostomatidae	Belostoma		1			2	1	1								1					
	Gerridae					1					1	1			1					7		3
	Gerridae	Trepobates		1	1	3	4		3	1	1	2	3	4	3	4		4			1	3
	Hydrometridae	Hydrometra				1			1					1		2						
	Notonectidae	Notonecta		1																		1
Plecoptera	Chloroperlidae										1				2							1
Odonata-Anisoptera	Aeshnidae	Basiaeschna		2	2		5	2	2	2	2	4	4	3	2	2	2	5	3	1		1
	Gomphidae						4	1	2	3	1			3				1		1	2	
	Gomphidae	Progomphus													1					7	1	3
	Cordulegastridae	Cordulegaster									1											
	Corduliidae	Epitheca							2													3
	Macromiidae	Macromia						1						1								
Odonata-Zygoptera	Calopterygidae	Calopteryx			10	3		1	5	1	10				12	6	9	4			7	3
	Coenagrionidae	Argia		7	8	4	17	2	13	8	2		2	6	2	5	1	7		7	8	1
	Coenagrionidae	Engallagma				3	20	4	18	3	5	55	2	27		2	2	3	3	7	4	
Diptera	Ceratopogonidae																		3			2
	Blood-red Chironomidae					1	7		5	11	11		2	6	2	8	1	18	1	20	17	2
	Other Chironomidae			4	4	9	3	3	8	4	2	2	2	1	1	12	1	4	1	15	2	
	Culicidae				3	1	3	1	2		1	2	2		4	2	1	2		1	1	3
	Simuliidae				4	1											2		1			
	Tabanidae				3	2	1			2	1		2	1		4	2	3			8	6

TABLE 11 – BENTHIC MACROINVERTEBRATE RESULTS, SEPTEMBER 2006

Parameter	Number of Taxa	MBI	Scraper/ Filter	EPT/ Chironomidae	% Dominant Taxa	EPT Index	CPOM	Community Loss	Jaccard Coefficient	Total Number Collected
Station 2	19	4.63	1.15	11.25	25	3	0.02	0.947	0.216	100
Station 5	15	4.36	0.02	14.00	46	4	0.05	1.0	0.367	100
Station 6	23	4.73	1.33	4.70	17	5	0.01	0.522	0.4	100
Station 7	24	5.74	0.25	0.20	20	2	0.09	0.625	0.282	100
Station 8	23	4.86	0.32	11.33	24	4	0.06	0.696	0.256	100
Station 9	27	5.60	2.17	1.54	18	5	0.06	0.407	0.395	100
Station 10	23	4.80	1.08	3.33	18	6	0.01	0.522	0.4	100
Station 14	27	5.02	9.75	2.31	20	5	0.04	0.333	0.472	100
Station 15	21	7.20	13.00	5.50	55	4	0.04	0.810	0.237	100
Station 16	19	4.73	0.16	0.50	43	1	0.02	0.842	0.286	100
Station 17	25	6.06	8.00	2.00	27	4	0.06	0.56	0.308	100
Station 18	22	4.37	21.50	13.66	31	6	0.05	0.454	0.5	100
Station 19	22	5.12	1.11	1.45	12	5	0.02	0.591	0.371	100
Station 20	24	4.07	0.15	29.00	22	6	0.02	0.542	0.351	100
Station 21	22	5.26	1.10	1.23	18	5	0.02	0.636	0.333	100
Station 22	12	4.20	0.53	43.00	35	4	0.00	1.5	0.267	100
Station 23	20	5.77	3.00	0.54	20	4	0.07	0.85	0.243	100
Station 24	20	5.07	1.63	2.16	17	4	0.02	0.65	0.394	100
Station 25	26	4.59	6.33	10.00	29	5	0.07	0	1	100

The station scores are compared to the reference station and assigned biological condition categories based on percent comparison. The reference station is literally an additional station that was sampled. The biological condition scoring criteria for each benthic macroinvertebrates parameter assigns numeric values based on specific percentage of comparability with the reference. Qualitative results are converted into quantifiable numeric values of 6 for nonimpaired, 4 for slightly impaired, 2 for moderately impaired, and 0 for severely impaired. The total metric score is then compared to the reference station to provide impairment category results based on >83% of the reference station for nonimpaired, 51-82% for slightly impaired, 18-50% for moderately impaired, and <17% comparability with the reference station for severely impaired. These results are shown in Table 12. Overall, the three highest biological quality stations (nonimpaired) are 14, 18 and 25 and the lowest biological quality (moderately impaired) is station 16, see Exhibit XII. Further discussion is contained in sections 3.5 and 3.8.



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TITLE: Stream Reach Biological Impairment	PROJECT: Anderson River Watershed Diagnostic Study		
BASE LAYER: N/A	PROJECT NO.: 06002	EXHIBIT: XII	SHEET: 1 OF: 1
Client: Perry County Soil & Water Conservation District 125 S. Eighth Street, Room 6 Cannelton, Indiana 47520	FILE NAME: N/A	DATE: 1/24/07	SCALE: NTS

E:\2006\06002\Reports\Natural Resources\Wetland\Exhibits\Main Exhibits\Exhibits For Tim\Exhibit XII 2006 Impairment Categories.mxd

TABLE 12 – BENTHIC MACROINVERTEBRATE BIOLOGICAL CONDITION SCORING, SEPTEMBER 2006

Parameter	Number of Taxa	MBI	Scraper/ Filter	EPT/ Chironomidae	% Dominant Taxa	EPT Index	CPOM	Community Loss	Total Score	Percent of Reference	Impairment Category
Station 2	4	6	0	6	4	0	2	4	26	56	Slighty
Station 5	2	6	0	6	0	4	6	4	28	61	Slightly
Station 6	6	6	2	2	6	6	0	4	32	70	Slightly
Station 7	6	4	0	0	4	0	6	4	24	52	Slightly
Station 8	6	6	0	6	4	4	6	4	36	78	Slightly
Station 9	6	4	2	0	6	6	6	6	36	78	Slightly
Station 10	6	6	0	2	6	6	0	4	30	65	Slightly
Station 14	6	6	6	0	4	6	6	6	40	87	Nonimpaired
Station 15	6	2	6	4	0	4	6	4	32	70	Slightly
Station 16	4	6	0	0	0	0	2	4	16	35	Moderately
Station 17	6	4	6	0	4	4	6	4	34	74	Slightly
Station 18	6	6	6	6	2	6	6	6	44	96	Nonimpaired
Station 19	6	6	0	0	6	6	2	4	30	64	Slightly
Station 20	6	6	0	6	4	6	2	4	34	74	Slightly
Station 21	6	6	0	0	6	6	2	4	30	64	Slightly
Station 22	2	6	0	6	2	4	0	4	24	52	Slightly
Station 23	4	4	4	0	4	4	6	4	30	64	Slightly
Station 24	4	6	2	0	6	4	2	4	28	61	Slightly
Station 25	6	6	6	6	4	6	6	6	46	100	Nonimpaired

Qualitative results are converted into quantifiable numeric values of 6 for nonimpaired, 4 for slightly impaired, 2 for moderately impaired and 0 for severely impaired.

4.6 Physical Evaluation Results

The purpose for evaluating the physical habitat features of the selected locations within the Lost River watershed is to quantify the condition and quality of the instream and riparian habitat. The use of the Ohio EPA QHEI was used and is included in Appendix V. The summary of the QHEI habitat scoring technique from the 2006 surveys are provided in Table 13.

TABLE 13 – QHEI RESULTS FOR ANDERSON RIVER, SEPTEMBER 2006

Parameter	Substrate	Instream Cover	Channel Morphology	Riparian Zone	Pool/ Current	Riffle/ Run	Gradient	Total	Percent of Reference	Classification Category
Station 1	5	11	14	5.75	7	0	4	46.75	57	Good
Station 2	19	19	16	9.5	11	5	10	89.5	110	Excellent
Station 3	4	11	12	6.25	7	0	4	44.25	54	Good
Station 4	9	15	13	4.25	7	0	6	54.25	67	Good
Station 5	15	14	16	8.5	9	3	6	71.5	88	Excellent
Station 6	19	16	13	4	7	5	4	68	83	Excellent
Station 7	7	19	7	5	7	0	10	55	67	Good
Station 8	17	19	9	4	10	3.5	4	66.5	82	Excellent
Station 9	11	18	10	4.25	11	3.5	4	61.75	76	Excellent
Station 10	15	17	8	3.5	8	3	6	60.5	74	Good
Station 11	16	15	17	9	7	0	10	74	91	Excellent
Station 12	16	9	14	7	3	0	8	57	70	Good
Station 13	9	14	16	9	9	0	10	67	82	Excellent
Station 14	18	15	16	7.5	9	5	10	80.5	99	Excellent
Station 15	18	14	10	4	10	4	10	70	86	Excellent
Station 16	18	16	10	5.5	9	3	6	67.5	83	Excellent
Station 17	8	15	10	3	7	0	10	53	65	Good
Station 18	18	15	14	9	9	5	6	76	93	Excellent
Station 19	15	15	10	4	10	2.5	6	62.5	77	Excellent
Station 20	16	12	13	6	9	4	4	64	79	Excellent
Station 21	10	8	7	3	6	1	4	39	48	Fair
Station 22	16	12	11	3.5	7	3	4	56.5	69	Good
Station 23	4	14	7	7	7	1	4	44	54	Good
Station 24	14	12	10	8	6	3	6	59	72	Good
Station 25	19	13	17	9.5	7	6	10	81.5	100	Excellent

4.7 Water Quality Evaluation Results

V3 performed the sampling events on April 24-26, 2006 (stormflow) and September 5-10, 2006 (baseflow). The field measured water quality parameters included temperature, conductivity, specific conductance, salinity, pH, dissolved oxygen, flow, and turbidity. Water quality data sheets for parameters taken in the field are included in Appendix V. V3 also collected water samples for water chemistry analysis in a laboratory for the following parameters: Ammonia, Nitrate, Nitrite, Total Kjeldahl Nitrogen, Dissolved Phosphorous, Total Phosphorous and *E. coli*. Results for the laboratory measured water quality are included in Appendix VI. Table 14 shows the results of the stormflow field measured water quality sampled on April 24-26, 2006. Table 15 shows the results of the stormflow laboratory measured water quality sampled on April 24-26, 2006. Table 16 shows the results of the baseflow field measured water quality sampled on September 5-10, 2006. Table 17 shows the results of the baseflow laboratory measured water quality sampled on September 7, 2006.

TABLE 14 – SUMMARY OF STORMFLOW SAMPLING WATER QUALITY DATA FOR ANDERSON RIVER, APRIL 24, 25 AND 26, 2006

Parameter	pH	Conductivity	Specific Conductance	Salinity	Air Temperature	Water Temperature	Dissolved Oxygen	Turbidity	Flow Volume	Date of Sampling	Time of Sampling
Units	-log [H+]	umhos/cm	umhos/cm @ 25°C	ppt	°C	°C	Mg/L	NTU	Ft^3/second	MM/DD	Military
Station 1	8.76	137.3	158.3	0.1	17.7	18	8.9	45	No Data	4/25/2006	7:30
Station 2	8.61	127.7	129	0.1	10	15.2	9.86	39	No Data	4/26/2006	7:40
Station 3	8.42	154	186.3	0.1	15	16	9.7	24	No Data	4/26/2006	16:45
Station 4	8.98	123.3	141.7	0.1	19	18.2	10	45	No Data	4/25/2006	16:00
Station 5	8.33	131.4	174.8	0.1	16	11.9	11.6	7.9	14.32	4/27/2006	9:00
Station 6	8.44	137.4	192.1	0.1	10.3	10.1	12.79	3.5	9.35	4/27/2006	8:00
Station 7	8.28	132.3	154.8	0.1	15	17.3	10.82	13	15.2	4/25/2006	18:30
Station 8	8.4	132.4	155.2	0.1	20	17.3	10.46	22	48.53	4/25/2006	16:30
Station 9	8.24	146.3	169	0.1	17	18	10.45	18	12.13	4/25/2006	17:45
Station 10	8.35	150	170.8	0.1	15.1	18.6	10.92	9.9	5.74	4/26/2006	17:00
Station 11	8.74	133.6	133.7	0.1	27	18.7	8.7	16	No Data	4/24/2006	18:30
Station 12	9.14	129.1	149.4	0.1	27	19.2	9.52	5.5	3.33	4/24/2006	17:45
Station 13	9.74	146	161.8	0.1	26	19.9	11.1	9	No Data	4/24/2006	16:30
Station 14	8.39	150.3	173	0.1	15.7	18.1	11.78	8.5	8.62	4/26/2006	15:30
Station 15	7.93	166.3	204.5	0.1	15.5	15.3	13.65	6.1	13.01	4/26/2006	12:00
Station 16	8.21	128.3	157.1	0.1	14.7	16.4	11.68	12	34.13	4/26/2006	12:50
Station 17	8.37	124.5	149.7	0.1	15.4	16.2	12.29	11	26.23	4/26/2006	13:30
Station 18	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Station 19	8.55	105.6	136.4	0.1	11	13.1	11.66	11	22.87	4/26/2006	8:30
Station 20	7.95	153	186.6	0.1	17	15.6	12.52	6.8	6.71	4/26/2006	9:30
Station 21	8.06	121	152.1	0.1	17	14.3	11.62	12	35.58	4/26/2006	11:00
Station 22	8.02	202.3	257.1	0.1	14	13.8	11.46	12	8.57	4/26/2006	10:15
Station 23	8.05	139.8	174.2	0.1	16	14.7	9.77	24	No Data	4/26/2006	10:40
Station 24	8.23	158.2	207.8	0.1	13	12.5	11.39	7.8	7.23	4/26/2006	9:45
Station 25	8.27	118.1	142	0.1	15.5	16.2	12.3	4.3	5.52	4/26/2006	14:20

TABLE 15 – SUMMARY OF STORMFLOW SAMPLING WATER QUALITY DATA FOR ANDERSON RIVER, APRIL 24, 25 AND 26, 2006

Parameter	Nitrogen, Ammonia	Nitrogen, Nitrate	Nitrogen, Nitrite	Nitrogen, Total Kjeldahl	Phosphorus, Dissolved	Phosphorus, Total	E. coli
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfu/100ml
Station 1	0.112	5.490	<0.010	<0.01	0.015	0.084	326
Station 2	0.159	4.730	0.014	1.120	0.052	0.076	248
Station 3	<0.010	7.200	0.015	<0.010	0.018	0.074	299
Station 4	0.309	4.140	0.012	0.560	0.048	0.082	66
Station 5	0.262	4.970	<0.010	<0.010	0.016	0.027	219
Station 6	0.099	5.830	<0.010	<0.010	0.011	0.011	42
Station 7	0.177	5.890	<0.010	<0.010	<0.010	0.027	>2,420
Station 8	0.116	4.690	0.013	<0.010	0.043	0.051	194
Station 9	0.089	4.880	<0.010	0.840	0.011	0.043	326
Station 10	0.438	7.410	<0.010	<0.010	<0.010	0.021	236
Station 11	0.124	6.170	0.018	0.420	0.012	0.047	No Data
Station 12	0.090	6.460	<0.010	0.140	<0.010	0.011	No Data
Station 13	0.069	3.690	<0.010	<0.010	<0.010	0.012	No Data
Station 14	0.102	3.740	<0.010	<0.010	<0.010	0.013	185
Station 15	0.125	4.210	<0.010	<0.010	0.013	0.024	1,414
Station 16	0.084	5.700	<0.010	<0.010	<0.010	0.023	85
Station 17	0.115	5.420	<0.010	<0.010	<0.010	0.013	71
Station 18	0.181	4.820	0.010	<0.010	<0.010	0.013	No Data
Station 19	0.202	6.190	<0.010	0.560	<0.010	0.030	155
Station 20	0.107	5.510	0.011	<0.010	0.036	0.053	140
Station 21	0.716	6.920	0.010	<0.010	0.042	0.052	411
Station 22	0.086	9.640	0.010	0.280	0.032	0.059	276
Station 23	0.216	6.710	0.014	0.280	<0.010	0.053	411
Station 24	0.147	10.900	<0.010	0.560	<0.010	0.046	205
Station 25	No Data	No Data	No Data	No Data	No Data	No Data	No Data

TABLE 16 – SUMMARY OF BASEFLOW SAMPLING WATER QUALITY DATA FOR ANDERSON RIVER, SEPTEMBER 5-10, 2006

Parameter	pH	Conductivity	Specific Conductance	Salinity	Air Temperature	Water Temperature	Dissolved Oxygen	Turbidity	Flow Volume	Date of Sampling	Time of Sampling
Units	-log [H+]	umhos/cm	umhos/cm @ 25°C	Ppt	°C	°C	Mg/L	NTU	Ft^3/second	MM/DD	Military
Station 1	8.31	214	231.2	0.1	17	21.1	3.74	38	--	9/8/2006	7:45
Station 2	7.99	203.8	221.7	0.1	18	20.4	5.61	17	1.25	9/8/2006	10:45
Station 3	8.14	266.3	291.8	0.1	26	20.3	4.15	17.8	--	9/9/2006	12:15
Station 4	8.45	197.8	218.8	0.1	17	19.9	2.18	14	--	9/9/2006	7:45
Station 5	8.35	207.8	237.2	0.1	21	18.5	6.63	100	0.21	9/8/2006	9:30
Station 6	8.57	305.8	295.1	0.1	27	26.7	8.50	2.4	0.69	9/8/2006	13:30
Station 7	8.04	209.4	225.8	0.1	26	21.5	3.60	8.07	0.58	9/8/2006	16:15
Station 8	8.14	204.7	220.4	0.1	15	21.3	5.55	12	0.63	9/9/2006	8:30
Station 9	8.03	264	281.2	0.1	23	21.5	6.61	11	0.15	9/9/2006	9:30
Station 10	7.67	337.4	362.4	0.2	26	21.4	10.02	9.4	0.19	9/9/2006	11:10
Station 11	7.67	253	285	0.1	21	18.9	1.52	9.5	--	9/6/2006	11:00
Station 12	8.59	55	58	0.0	24	23.5	9.03	5.2	--	9/6/2006	13:00
Station 13	8.13	302	321	0.2	26	23	10.20	55	--	9/6/2006	16:30
Station 14	8.10	293.8	325.5	0.2	28	19.9	7.07	21	0.12	9/10/2006	12:15
Station 15	7.96	331.2	361.8	0.2	26	21	7.25	5.3	0.19	9/7/2006	13:00
Station 16	8.14	218.6	233.9	0.1	24	21.3	8.85	15	0.95	9/6/2006	15:00
Station 17	7.90	240.3	237.6	0.1	24	25.6	8.25	31	1.46	9/6/2006	13:00
Station 18	8.19	294.6	310.8	0.2	17	21.4	9.71	40	1.07	9/6/2006	8:45
Station 19	8.28	211.9	228.5	0.1	20	21.1	6.71	14	0.59	9/10/2006	9:45
Station 20	8.56	206.3	233.9	0.1	18	18.9	9.13	7.29	0.66	9/10/2006	8:30
Station 21	9.21	225.4	227.6	0.1	26	24.5	13.69	13	2.54	9/5/2006	14:30
Station 22	8.50	391.5	422	0.2	25	21.2	12.24	4.9	0.87	9/5/2006	18:00
Station 23	8.88	213.9	239.5	0.1	25	21	7.56	19	4.99	9/5/2006	18:00
Station 24	8.55	353.9	403.3	0.2	23	18.5	10.51	9.1	0.31	9/7/2006	11:00
Station 25	8.14	202.7	227.4	0.1	22	19.1	8.53	0.6	0.22	9/6/2006	10:30

TABLE 17 – SUMMARY OF BASEFLOW SAMPLING WATER QUALITY DATA FOR ANDERSON RIVER, SEPTEMBER 7, 2006

Parameter	Nitrogen, Ammonia	Nitrogen, Nitrate	Nitrogen, Nitrite	Nitrogen, Total Kjeldahl	Phosphorus, Dissolved	Phosphorus, Total	E. coli
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfu/100ml
Station 1	0.107	1.57	0.041	0.98	0.043	0.111	261
Station 2	0.103	1.23	0.021	1.12	0.029	0.053	79
Station 3	0.146	2.05	0.036	1.12	0.040	0.098	613
Station 4	0.346	1.18	0.025	1.68	0.046	0.092	2,419
Station 5	0.112	0.782	0.014	1.12	0.029	0.141	980
Station 6	0.113	0.875	<0.010	0.84	0.016	0.031	91
Station 7	0.111	1.17	0.010	0.56	0.017	0.040	147
Station 8	0.096	1.17	<0.010	1.40	0.021	0.050	128
Station 9	0.104	0.913	<0.010	1.40	0.018	0.054	69
Station 10	0.148	1.11	0.030	0.70	0.029	0.052	461
Station 11	0.213	1.180	<0.010	<0.01	<0.010	0.022	--
Station 12	<0.010	0.325	<0.010	0.42	<0.010	0.025	--
Station 13	<0.010	1.130	<0.010	0.28	<0.010	0.061	--
Station 14	0.074	1.13	<0.010	0.56	<0.010	0.035	461
Station 15	0.127	2.35	<0.010	0.56	0.036	0.063	1,413
Station 16	0.065	1.71	0.030	0.70	<0.010	0.026	104
Station 17	0.021	1.33	0.011	<0.01	<0.010	0.039	77
Station 18	0.021	0.332	<0.010	<0.01	0.013	0.044	143
Station 19	0.149	1.62	0.015	0.56	0.013	0.062	613
Station 20	0.031	1.57	<0.010	0.14	0.029	0.046	365
Station 21	0.148	1.72	0.012	0.14	0.016	0.039	410
Station 22	0.027	2.33	0.011	0.28	0.022	0.038	488
Station 23	0.191	1.21	0.026	0.56	0.041	0.083	461
Station 24	0.105	1.29	0.020	0.70	<0.010	0.022	487
Station 25	<0.010	0.790	<0.010	<0.01	<0.010	0.018	22

4.8 Discussion of Results

Most stations showed a very healthy Total Number or Taxa. Only Stations 5 and 22 were Moderately Impaired in this area. Most stations were also healthy for EPT Index. This stands for the number of taxa that are identified for the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). These three orders of insects are considered indicative of healthy macroinvertebrate communities and high water quality. The three stations Severely Impaired for this metric were Stations 2, 7, and 16. Station 16 had the worst percentage which was 20% of the reference or just one taxon of EPT's.

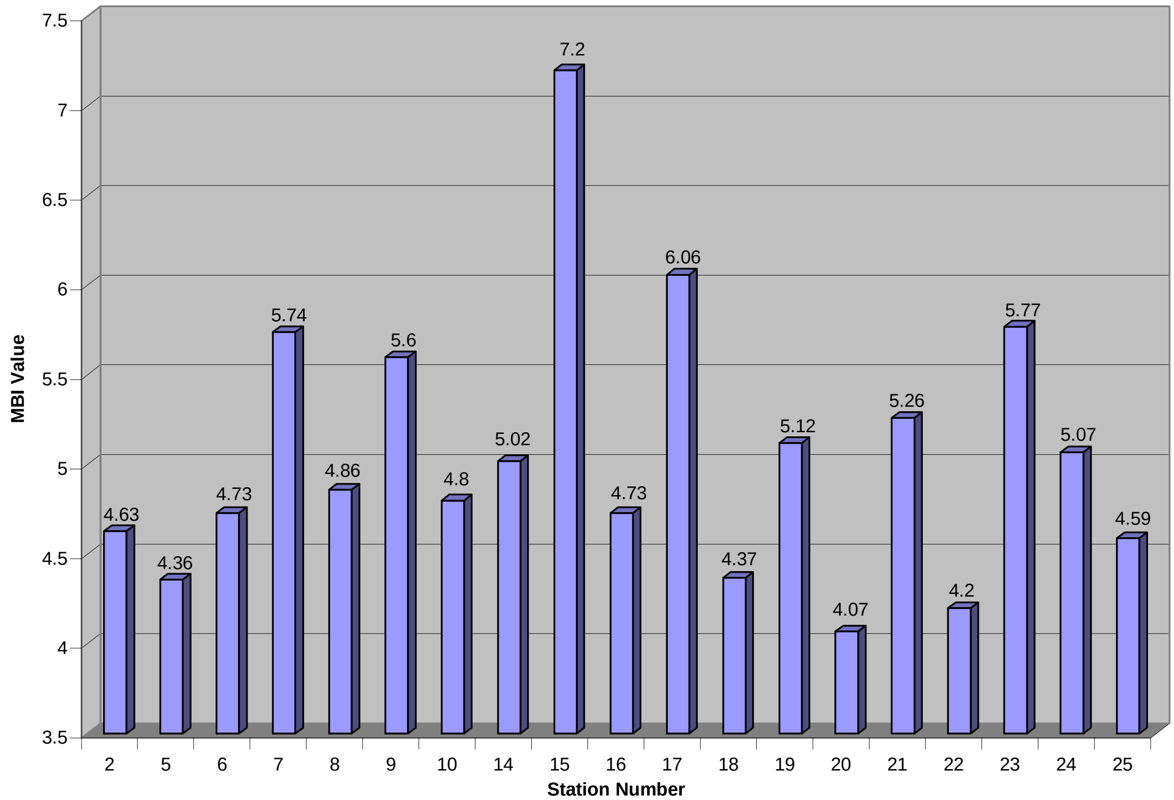
Composition measures such as Percent Contribution of Dominant Taxa will decrease as water quality, habitat diversity and habitat suitability improve. Three stations were Severely Impaired for this metric and two stations were moderately impaired. Ratio of EPT to Chironomidae (midges) reflects good biotic condition if the sensitive groups (EPT) demonstrate a substantial representation. However, if the Chironomidae have a disproportionately large number of individuals in comparison to the sensitive groups then this situation is indicative of environmental stress. This metric overall did not score well. Nine stations were Severely Impaired and two stations were Moderately Impaired.

Tolerance/Intolerance measures are intended to be representative of relative sensitivity to perturbation. The Hilsenhoff Biotic Index developed in 1982 is oriented towards the detection of organic pollution but is generally not specific to the type of stressor. The Modified Biotic Index (MBI) was also developed to detect organic pollution and is based on the original species level index developed by Hilsenhoff. Pollution tolerance values range from 0 to 10 and increase as water quality decreases. The lower the MBI, the greater the number of pollution intolerant species (see Exhibit XIII). Most of the stations showed a healthy MBI. Only Station 15 was Moderately Impaired for this metric.

The evaluation of Functional Feeding Groups through the ratio of scraper to filtering collector reflects the riffle/run community food base. Filtering collectors are sensitive to toxicants bound to fine particles and should be the first group to decrease when exposed to steady sources of such toxicants. Ten stations were Severely Impaired for this metric and two stations were Moderately Impaired. The ratio of shredders to nonshredders through the CPOM evaluation demonstrates the riparian zone impacts from the toxicants that are readily adsorbed into the plant parts within the CPOM. Three stations were Severely Impaired for this metric and six stations were Moderately Impaired for this metric.

Community Loss Index measures how similar the reference station is to the station that is being looked at. It looks at which taxa are present at the reference station, sample station and how many taxa these stations have in common. The closer the Community Loss Indexes number is to zero, the more similar the sampling station is to the reference station and the more likely it is higher quality. The USEPA provides the highest Biological Condition Score for Community Loss Indexes that are less than 0.5.

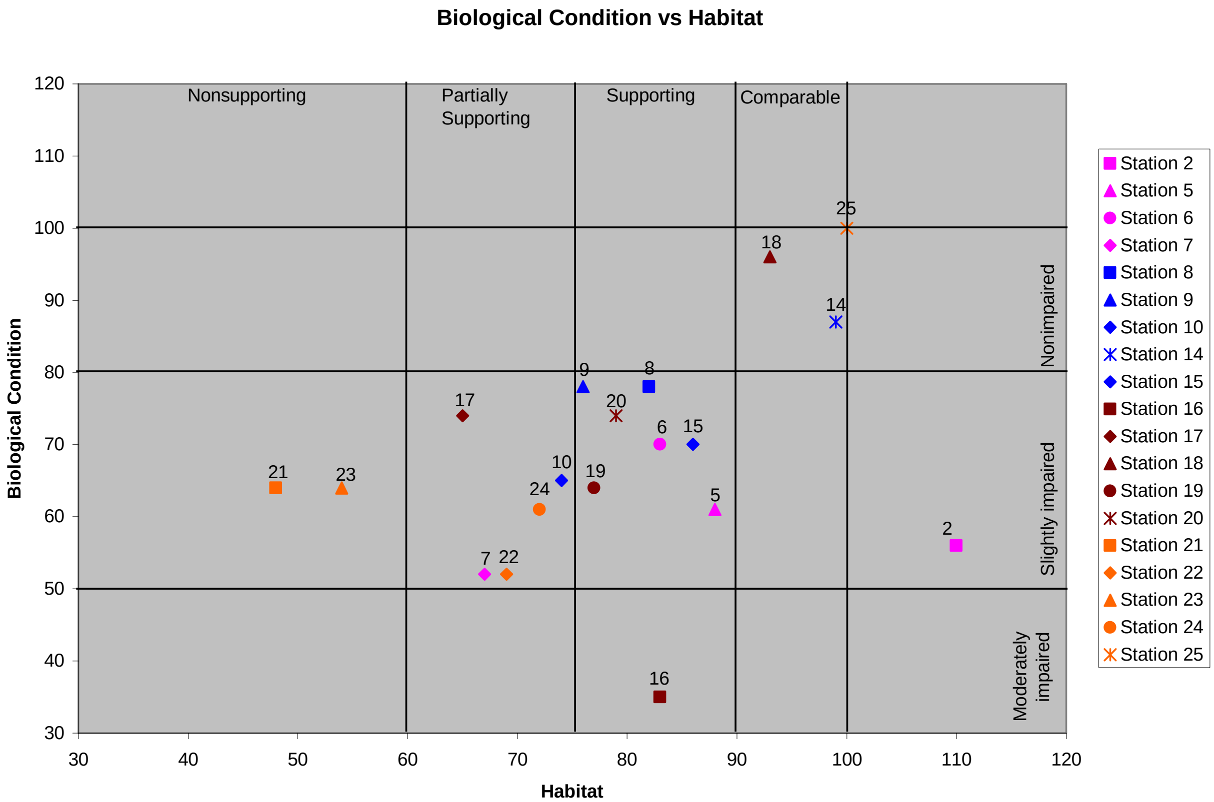
EXHIBIT XIII – MODIFIED BIOTIC INDEX (MBI) FROM BIOLOGICAL CONDITION, SEPT 2006



Habitat incorporates all aspects of physical and chemical constituents along with the biotic interactions. Habitat includes all of the instream and riparian habitat that influences the structure and function of the aquatic community in a stream. The presence of an altered habitat structure is considered one of the major stressors of aquatic systems. The presence of degraded habitat can sometimes obscure investigations on the effects of toxicity and/or pollution. The Ohio EPA QHEI total score values are classified within four quality categories: Excellent = 76 to 100, Good = 51 to 75, Fair = 26 to 50, Poor = 0 to 25.

Exhibit XIV graphically displays comparisons of each of the nineteen stations to the reference station. The reference station is normalized at 100% of the habitat scoring and 100% of the biological condition. This represents the achievable potential of each sampling station. The biological data source for this graph can be found on Table 12, the habitat data source can be found on Table 13.

EXHIBIT XIV – PERCENTAGE OF REPRESENTATIVE REFERENCE STATION FOR BIOLOGICAL CONDITION AND HABITAT, SEPT 2006



The reference stream represents regional expectations with 100 for both habitat and biological condition. The relationship between habitat quality and biological condition demonstrates that good quality habitat will support high quality biological communities, and responses to minor alterations in habitat will be subtle and of little consequence. Discernible biological impairment results as habitat quality continues to decline. In areas of good or excellent habitat, biological communities will reflect degraded conditions when water quality effects are present. This graph demonstrates a condition where organic pollution or toxicants will adversely affect biological condition regardless of the quality of the habitat.

Stations 14 and 18 are both Nonimpaired for biological condition and Comparable for habitat. Stations should be in comparable categories, for instance stations in the Slightly Impaired for biological condition should also be Partially Supporting or Supporting for habitat. In these stations the limiting factor on biological quality could be habitat. So if habitat is increased biological quality should also increase. Stations such as 2 and 16 that have a good habitat scores should also have good biological scores. It may be due to lower water quality that these stations do not have as high of biological scores. Opposite of that are Stations 21 and 23 that are Nonsupporting for habitat and Slightly Impaired for biological condition. It may be that these stations have very good water quality or a good source for food keeping the biological score relatively high. If these stations have better habitat conditions the biological communities may stay the same or increase in quality. If nothing is done, biological communities could decrease dramatically due to the lack of habitat.

4.9 IDEM Data

To support or contradict data collected by V3 on the Anderson River in 2006, water-quality data obtained and evaluated from agencies included Indiana Department of Environmental Management (IDEM), the U.S. Forest Service, U.S. Fish and Wildlife Service, Indiana Biological Survey and the U.S. Geological Survey.

Chemistry data was evaluated from sampling efforts performed during 2000 – 2005. Most parameters were within normal ranges throughout the basin. However, some parameters are worth further mention. Most of the samples collected indicated phosphorus levels above 0.03mg/L. At these levels, phosphorus has been documented to cause algal blooms (Vollenweider 1968, Wetzel 1975), so there is a need to address nutrient concentrations throughout the basin. IDEM uses a value of 0.3mg/L to help determine if a stream is impaired and should be listed on the Indiana 303(d) list of impaired waters. It is interesting to note that only one of these samples, taken in 2005 on Rockhouse Branch in Perry County exceeded this threshold with a value of 0.33mg/L. In addition, Friday Branch in Dubois County had a violation of Ammonia in 2005. Till Drain in Perry County also had violations of the water-quality criteria for total dissolved solids and sulfate.

Bacteriological contamination is common throughout Indiana, and several portions of the Anderson River are no exception. Where *E. coli* was sampled, many sites violated the state standard of 235 colony forming units per 100ml of water.

In June through August of 2000 an IDEM study looked at organics and pesticides in the Anderson River Watershed. No values were found above lab detections limits for any of the analyzed constituents. Metals were also studied in 2000 and again in 2005 with very few samples providing readings above laboratory detection limits.

Most field measurements evaluated from 2000 – 2005 within the Anderson River were within normal limits with the exception of two parameters, pH and dissolved oxygen (DO). A number of locations had pH values above 9.0. State standards dictate that pH should range between 6.0 and 9.0. IDEM uses a pH value consistently outside of this range to indicate that a waterbody is impaired. DO is essential to the survival of aquatic life. Standards dictate that DO levels should never fall below 4.0 mg/L, or have an average value less than 5.0 mg/L. Several stations throughout the Anderson River were found to violate this standard. In addition, abnormally high values for DO can indicate a system which experiences high fluctuations in dissolved oxygen content. Therefore, IDEM considers DO values over 12 mg/L to indicate a system that is possibly impaired.

4.10 Fish Consumption Advisory

Each year the Indiana State Department of Health in conjunction with the Indiana Department of Natural Resources and IDEM published a fish consumption advisory for Indiana. Advisories are based on actual fish tissue data collected from Indiana's rivers, lakes, and reservoirs. Guidelines are then published so that the public can make informed decisions based on what type of fish they would like to eat, and the amount of fish that is safe to consume within a given time period.

An IDNR fisheries survey was performed in 1989 (IDNR, 1993). The water quality measurements taken within the Anderson River Watershed were within normal levels for Indiana streams for the following parameters: pH, alkalinity, NH3, NO2/NO3, ortho-phosphate, total phosphorus, BOD and E. coli. Nine of the ten E. coli. measurements were above Indiana's minimum water quality standard of 135 colony forming units/100 ml, however, this was reported as being "not unusual for Indiana streams" (IDNR, 1993).

Fish consumption advisories are based on specific contaminants that can bio-accumulate in fish tissue, polychlorinated biphenyls (PCBs), pesticides, and heavy metals such as mercury. Criteria for these advisories were developed by the Great Lakes Sport Fish Advisory Task Force. Advisories fall in one of the five categories listed below (Table 18). Advisories are different for specific high risks groups such as pregnant women and women who are breastfeeding.

TABLE 18 ADVISORY GROUPS OF THE INDIANA FISH CONSUMPTION ADVISORY*

Group Number	Definition
Group 1	Unrestricted Consumption **One meal per week for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 2	Limit to one meal per week (52 meals per year) for adult males and females. **One meal per week for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 3	Limit to one meal per month (12 meals per year) for adult males and females. **One meal per week for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 4	Limit to one meal every 2 months (6 meals per year) for adult males and females. **One meal per week for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15.**
Group 5	**No consumption (DO NOT EAT).**

*Data from 2006 Indiana Fish Consumption Advisory

Fish consumption advisories for the Anderson River watershed include the following (Table 19):

TABLE 19. FISH CONSUMPTION ADVISORY SPECIES LIST FOR THE ANDERSON RIVER WATERSHED*

Species	Size Class (inches)	Contaminant	Advisory**	Waterbody Name
Carp	15-20	PCBs	Group 3	All Rivers and Streams
Carp	20-25	PCBs	Group 4	All Rivers and Streams
Carp	25+	PCBs	Group 5	All Rivers and Streams
Black Buffalo	25+	PCBs	Group 3	Anderson River (Spencer County)
Channel Catfish	13+	PCBs	Group 3	Anderson River (Spencer County)

*Data from 2006 Indiana Fish Consumption Advisory

**Any fish not specifically listed in the table above should be considered a Group 2 advisory.

5.0 NONPOINT SOURCE POLLUTION

The characteristics of watershed areas greatly influence the quality of the respective receiving water. In general, large watershed areas have the potential to receive more pollutants from runoff than small watershed areas. The following equations, tables and discussions summarize the Anderson River Watershed nonpoint source pollution calculations.

Sediment Loading Methods

This section describes the efforts taken to quantify the sediment loading within each of the twenty-five subwatersheds delineated by V3. Since the land use for these subwatersheds are predominately agricultural and undeveloped, the USEPA's Simple Method for Watershed Sediment Yield was used (USEPA, no date). The watershed sediment yield due to surface erosion is:

$$Y = Sd \sum XA$$

Where:

Y = annual sediment yield (tons/year)
Sd = watershed sediment delivery ratio
X = erosion from entire source area (tons/acres)
A = source area (acres)

The Universal Soil Loss Equation (USLE) was used to estimate the erosion (X) from each subwatershed. The Universal Soil Loss Equation quantifies soil erosion using the following factors: rainfall and runoff erosiveness, soil erodibility, slope length, slope steepness, cover management practices (i.e. land use), and conservation practices. These factors are predicted from meteorological, soil and/or erosion research data for each of the locations. The Universal Soil Loss Equation is:

$$X = 1.29(E)(K)(ls)(C)(P)$$

Where:

X = soil loss (tons/year)
E = rainfall/runoff erosivity index (ft tonf in/ton hour year)
K = soil erodibility (tons/acre)
ls = topographic factor
C = cover/management factor
P = supporting practice factor

A rainfall factor used to estimate average annual soil loss must include the cumulative effects of many moderate sized storms as well as the effects of the occasional severe storms. The numerical value used for E in the USLE equation must quantify the effect of raindrop impact and must also reflect the amount and rate of runoff likely to be associated with the rain event. The erosion index (E) devised by Wischmeier (1962) meets these requirements better than any of the many other rainfall parameters and groups of parameters tested. The Isoerodent Map of the Eastern United States (USEPA) shows this relationship and was used to obtain the erosivity index value for the Anderson River Watershed.

Soil erodibility is a complex property and is thought of as the ease with which soil is detached by splash during rainfall and/or by surface flow. The soil erodibility factor (K) in the USLE equation accounts for the influence of soil properties on soil loss during storm events on upland areas. The K values for the Anderson River subwatersheds were obtained from county specific soil survey information.

The effect of topography on erosion in the USLE equation is accounted for by the ls factor. Slope length is defined as the horizontal distance from the origin of overland flow to the point where either; the slope gradient decreases enough that deposition begins or runoff becomes concentration in a defined channel. In general, the potential for erosion increases as the steepness on the slope increases. Both slope length and steepness substantially affect sheet and rill erosion estimated by the USLE equation. One constant ls factor was used for all of the subwatersheds. The C factor is used to reflect the effect of management practices on erosion rates, and is the factor used most often to compare the relative impacts of cover management options. The C factor indicates how the practices will affect the average annual soil loss and how that soil loss potential will be distributed in time. The support practice factor (P) in the USLE equation is the ratio of soil loss with a specific support practice to the corresponding loss with upslope and downslope tillage. Soil-disturbing practices oriented on or near the contours that result in storage of moisture and reduction of runoff are used as support practices. There are no conservation practice data specific to the Anderson River Watershed and therefore a value of 1 was used.

The sediment load modeling results are summarized in Table 20. Sediment loading thresholds do not exist for this model, and target values created from the model are not able to be finalized. However, the most significant contributors of sediment loading within the watershed can be prioritized as locations where sediment loading prevention measures would have the greatest benefit. Station 20 along Ferdinand Run provided the highest contribution of sediment loading, and is the highest priority for implementing streambank stabilization projects, erosion control projects, grassed conservation buffers or forested riparian buffers. The second highest contributor of sediment loading is Station 22 along Blackhawk Creek (97% of the highest loading value), thus providing the subwatershed location which would provide the second greatest benefit to implementing sediment minimization projects. The third and fourth highest contributors are Station 6 along Kraus Creek and Station 9 along Little Sulphur Creek, at 79% and 76% of the highest loading value, respectively. A numerical break exists within the dataset projections, as all other stations have less than 70% of the highest loading value.

TABLE 20 ANNUAL SEDIMENT LOADING

V3 Subwatershed	Waterbody	Sediment Load (ton/year)	Area (acres)	Sediment Loading (ton/acre/year)
Station 1	Anderson River	24,699	162,323	0.15
Station 2	Middle Fork Anderson River	11,164	67,319	0.17
Station 3	Anderson River	11,861	76,148	0.16
Station 4	Middle Fork Anderson River	3,857	25,390	0.15
Station 5	Brushy Fork	1,327	5,866	0.23
Station 6	Kraus Creek	1,675	6,402	0.26
Station 7	Theis Creek	1,353	6,103	0.22
Station 8	Sulphur Fork Creek	3,394	17,886	0.19
Station 9	Little Sulphur Creek	1,421	5,584	0.25
Station 10	Lanman Run	422	2,695	0.16
Station 11	Sulphur Fork Creek	618	2,809	0.22
Station 12	Winding Branch Creek	37	543	0.07
Station 13	Middle Fork Anderson River	1,948	9,056	0.22
Station 14	Middle Fork Anderson River	745	3,982	0.19
Station 15	Sigler Creek	1,453	7,523	0.19
Station 16	Anderson River	2,604	18,635	0.14
Station 17	Anderson River	1,983	12,943	0.15
Station 18	Mitchell Creek	959	5,357	0.18
Station 19	Hurricane Creek	1,398	10,314	0.14
Station 20	Ferdinand Run	1,143	3,513	0.33
Station 21	Ferdinand Run	2,617	14,647	0.18
Station 22	Blackhawk Creek	1,855	5,769	0.32
Station 23	Anderson River	7,900	54,639	0.14
Station 24	Swinging Creek	709	3,563	0.20
Station 25	Anderson River	434	3,300	0.13

Phosphorus Loading Methods

Phosphorus loadings within the Anderson River Watershed were also calculated for each of the subwatersheds delineated by V3. The USEPA's Simple Method for Watershed Particulate Phosphorus was used. This method calculates phosphorus loadings based on the sediment yield, phosphorus concentration in the soil and the nutrient enrichment ratio (USEPA, no date).

The watershed phosphorus yield due to surface erosion is:

$$W = 0.001Sd \sum CsXA$$

Where:

W = particulate phosphorus load in runoff (kg/acre)
Sd = watershed sediment delivery ratio
Cs = concentration of phosphorus in eroded soil (mg/kg)
X = soil loss (tons/year)
A = source area (acres)

Similarity between the equations used for sediment loading and phosphorus loading, together with the GIS data assembled during this study formed a cohesive understanding of the relationship between suspended sediment particles and the attached phosphorus nutrients which accompany them. The watershed sediment delivery ratio (Sd), soil loss (X) and source area (A) were previously incorporated as a part of the sediment loading calculations. Concentrations of phosphorus in eroded soil (Cs) was assumed to be an average of existing phosphorus concentration by soil type involvement.

The phosphorus load modeling results are summarized in Table 21. Phosphorus loading thresholds do not exist for this model, and target values created from the model are not able to be finalized. However, the most significant contributors of phosphorus loading within the watershed can be prioritized as locations where phosphorus loading prevention measures would have the greatest benefit. Station 20 along Ferdinand Run provided the highest contribution of sediment loading, and is the highest priority for implementing nutrient management, contour buffer strips, field stripcropping, riparian buffers and grass filterstrips. The second highest contributor of phosphorus loading is Station 22 along Blackhawk Creek (98% of the highest loading value), thus providing the subwatershed location which would provide the second greatest benefit to implementing sediment minimization projects. The third and fourth highest contributors are Station 6 along Kraus Creek and Station 9 along Little Sulphur Creek, at 81% and 79% of the highest loading value, respectively. A numerical break exists within the dataset projections, as all other stations have less than 70% of the highest loading value.

TABLE 21 ANNUAL PHOSPHORUS LOADING TABLE

V3 Subwatershed	Waterbody	Phosphorus Load (kg/year)	Area (acres)	Phosphorus Loading (kg/acre/year)
Station 1	Anderson River	32,602	162,323	0.20
Station 2	Middle Fork Anderson River	14,737	67,319	0.22
Station 3	Anderson River	15,656	76,148	0.21
Station 4	Middle Fork Anderson River	5,091	25,390	0.20
Station 5	Brushy Fork	1,752	5,866	0.30
Station 6	Kraus Creek	2,210	6,402	0.35
Station 7	Theis Creek	1,786	6,103	0.29
Station 8	Sulphur Fork Creek	4,481	17,886	0.25
Station 9	Little Sulphur Creek	1,876	5,584	0.34
Station 10	Lanman Run	557	2,695	0.21
Station 11	Sulphur Fork Creek	816	2,809	0.29
Station 12	Winding Branch Creek	49	543	0.09
Station 13	Middle Fork Anderson River	2,571	9,056	0.28
Station 14	Middle Fork Anderson River	984	3,982	0.25
Station 15	Sigler Creek	1,918	7,523	0.26
Station 16	Anderson River	3,437	18,635	0.18
Station 17	Anderson River	2,617	12,943	0.20
Station 18	Mitchell Creek	1,265	5,357	0.24
Station 19	Hurricane Creek	1,845	10,314	0.18
Station 20	Ferdinand Run	1,508	3,513	0.43
Station 21	Ferdinand Run	3,454	14,647	0.24
Station 22	Blackhawk Creek	2,449	5,769	0.42
Station 23	Anderson River	10,427	54,639	0.19
Station 24	Swinging Creek	936	3,563	0.26
Station 25	Anderson River	573	3,300	0.17

6.0 PRIORITIZING POTENTIAL PROJECTS

This diagnostic study of the Anderson River revealed several problems throughout the watershed. Many sites had impaired biotic communities, degraded habitat, problematic nutrient levels, high bacteria counts (E. coli), and heavy sediment and phosphorus loads. Many of these problems can be tied to non-point sources of pollution. Failing septic systems, that have been considered to be point sources or non-point sources of pollution depending on how they are evaluated, may also be problematic in the watershed. To address these problems it is necessary to implement land use best management conservation practices. These Best Management Practices (BMPs) are behaviors, or ways of conducting business and using the land that are more environmentally friendly, and are often beneficial economically.

Much of the agricultural land throughout the basin is located near the streams in the valleys. These valley areas are often located in the floodplain, so are at greater risk for flooding and consequential erosion. This flooding can carry sediment and nutrients from farm fields into the adjacent streams. In addition, much of the pasture land is also in the floodplain or on steeper slopes along the streams, so nutrients, sediment, and other contaminants can easily be washed into the adjacent streams. There are many BMPs that address these non-point source issues, and many of them can be funded through programs offered by the United States Department of Agriculture (USDA). Table 22 below lists a number of practices; the programs that can help fund these practices, and the resulting positive effects of the practice.

TABLE 22. ON-FARM CONSERVATION PRACTICES SUPPORTED BY THE USDA TO HELP IMPROVE WATER QUALITY*

Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP), Conservation Security Program (CSP), Wildlife Habitat Incentives Program (WHIP), Forest Land Enhancement Program (FLEP), Grassland Reserve Program (GRP), Wetland Reserve Program (WRP)

Desired Effect	Practices	USDA Programs
Reduced Soil Erosion	Grassed waterways Terraces Grassed conservation buffers Field boarders Contour buffer strips	CRP, EQIP, CSP
Reduced Wind Damage	Residue management Shelterbelts Windbreaks Field stripcropping	CRP, EQIP, CSP
Conservation of soil and water resources	Nutrient management Pest management Cover crops Efficient water management Riparian buffers Conservation tillage	CRP, EQIP, CSP
Stream Stabilization	Forested riparian buffers Grass filterstrips Livestock exclusion Streambank protection Watering facilities	CRP, EQIP, CSP, WHIP, FLEP
Manure Management	Waste storage structures and lagoons Nutrient management Compost facilities Manure spreading	EQIP, CSP
Grassland Management	Prescribed grazing Pest management Prescribed fire Fencing Brush Management	EQIP, CRP, WHIP, GRP
Wildlife Habitat	Rotational grazing Wetland restoration Grassland restoration Conservation buffers Stream habitat improvement	WHIP, CRP, WRP, GRP, EQIP, CSP, FLEP
Forest Management	Tree planting Forest stand improvement and thinning Prescribed burning Invasive plant control	FLEP, WHIP, CRP, EQIP, Forest Stewardship Program, Forest Legacy Program

*Information provided by the Natural Resources Conservation Service.

As land is cleared for farming, industry, or other such practices, the amount of run-off, or water flowing off the land and into the river system, increases. This increased flow can cause detrimental changes in the rivers themselves such as increased bank erosion, destruction of aquatic habitat, excessive siltation, and altered stream geomorphology. Practices to slow down this runoff such as filter strips and restored or created wetlands, can be very beneficial in alleviating the problem in addition to providing benefits such as wildlife habitat and reduced flooding downstream. In addition, there are many techniques and practices that can be used to help stabilize stream banks to control further erosion

Along with the physical damage that can result to a stream ecosystem from increased run-off, is the physical damage that can result when cattle are allowed to have direct access to rivers and streams. As cattle enter and exit a stream they can cause stream bank erosion and destruction of aquatic habitat, in addition to increased bacteria counts due to their waste. Best management practices such as fencing cattle away from streams, providing them with an alternative water source and maintaining that buffer between pasture land and the adjacent stream can be of great benefit.

The highest priorities for implementation of land use best management conservation practices within the Anderson River Watershed are shown on Exhibit XV and include the following:

- The area delineated as Station 16, within the 18,635 acres of the Anderson River Subwatershed. This area was the worst biologically impaired subwatershed, and the only station of this watershed study which scored within this impairment category. Tangible steps toward remediating this impairment may include reducing negative effects on the biological community through minimizing soil erosion or through improving stream stabilization. Improvements to water quality will have a gradual effect on improving the biological community, however, habitat enhancements have the potential to have a more immediate and measureable effect.
- The area delineated as Station 21, within the 14,647 acres of the Ferdinand Run Subwatershed. This area had the lowest score for instream and riparian habitat within the watershed, and was one of only two stations within the watershed study which was classified within the "Nonsupporting" habitat quality category. Implementation of streambank stabilization, riparian buffers, riffle creation or instream cover projects would improve the degraded habitat conditions at this location.
- Similar to the previous bullet, the area delineated as Station 23, within the 55,587 acres of the Anderson River Subwatershed. This area had the second lowest score for instream and riparian habitat within the watershed, and was one of only two stations within the watershed study which was classified within the "Nonsupporting" habitat quality category. Similarly, implementation of streambank stabilization, riparian buffers, riffle creation or instream cover projects would improve the degraded habitat conditions at this location as well.
- The area delineated as Station 24, within the 3,563 acres of the Swinging Creek Subwatershed. This area had the only level of nitrate which exceeded the state and national water quality standards for safe drinking water. The spring result from April was 10.9 mg/L. Buffer strips, riparian buffers, nutrient management and soil erosion

reduction all contribute to reducing nitrate levels within surface water. Groundwater monitoring should be performed to determine if surface water concentrations are contaminating residential drinking water wells.

- Similar to the previous bullet, the area delineated as Station 22, within the 5,769 acres of the Blackhawk Creek Subwatershed had high spring nitrate levels. The result of the April test was 9.64 mg/L, which is very close to the 10.0 mg/L nitrate level of the safe drinking water standards. Buffer strips, riparian buffers, nutrient management and soil erosion reduction all contribute to reducing nitrate levels within surface water.
- The area delineated as Station 15, within the 7,523 acres of the Sigler Creek Subwatershed. Several of the stations exceeded the 235 cfu/100ml of E. coli bacteria state standard for surface water quality, but only one station during both spring and fall sampling had concentrations over 1,000. This station was at 1,414 cfu/100ml during both evaluations. This area is one of three extremely high E. coli areas identified in this study. There is potential for this source to be either from leaking septic tanks or from agricultural runoff through concentrated animal waste. Replacing failed septic systems and implementing manure management programs would be effective measures to improve these high bacteria concentrations. Riparian buffers will also serve to improve the concentrations in the event that the source is agricultural.
- The area delineated as Station 7, within the 6,103 acres of the Theis Creek Subwatershed. This station had the highest count of E. coli bacteria during this study, a value of greater than 2,420 cfu/100ml. In the fall, the value was only 147, which is below the state standard of 235 cfu/100ml. Implementing manure management programs and creating riparian buffers will improve the concentrations of bacteria within the surface water at this location.
- The area delineated as Station 4, within the 25,291 acres of the Middle Fork Anderson River Subwatershed. This station had an extremely high count of E. coli bacteria during the fall sampling effort of greater 2,420 cfu/100ml. In the spring, the value was only 66, which is well below the state standard of 235 cfu/100ml. There is potential for this source to be either from leaking septic tanks or from agricultural runoff through concentrated animal waste, as is the case with Station 15. Replacing failed septic systems and implementing manure management programs would be effective measures to improve these high bacteria concentrations. Riparian buffers will also serve to improve the concentrations in the event that the majority of the source is agricultural.
- The area delineated as Station 20, within the 3,513 acres of the Ferdinand Run Subwatershed. This area is the most significant source of both sediment loading and phosphorus loading. The results were 0.33 tons/acre/year of sediment and 0.43 kg/acre/year of phosphorus. Tangible steps toward remediating this impairment include reducing sediment and phosphorus loading through minimizing soil erosion from stormwater runoff and wind, through improving stream stabilization and soil and water conservation practices. Implementation projects including grassed waterways, vegetated buffer strips, terraced farming, residue management, windbreaks, nutrient management, riparian buffers, conservation tillage and others listed in Table 22 can all assist in improving the water quality within the Anderson River watershed with respect to sediment and phosphorus loading. These measures hold true for the discussion of Stations 22, 6 and 9, which follows immediately herein.

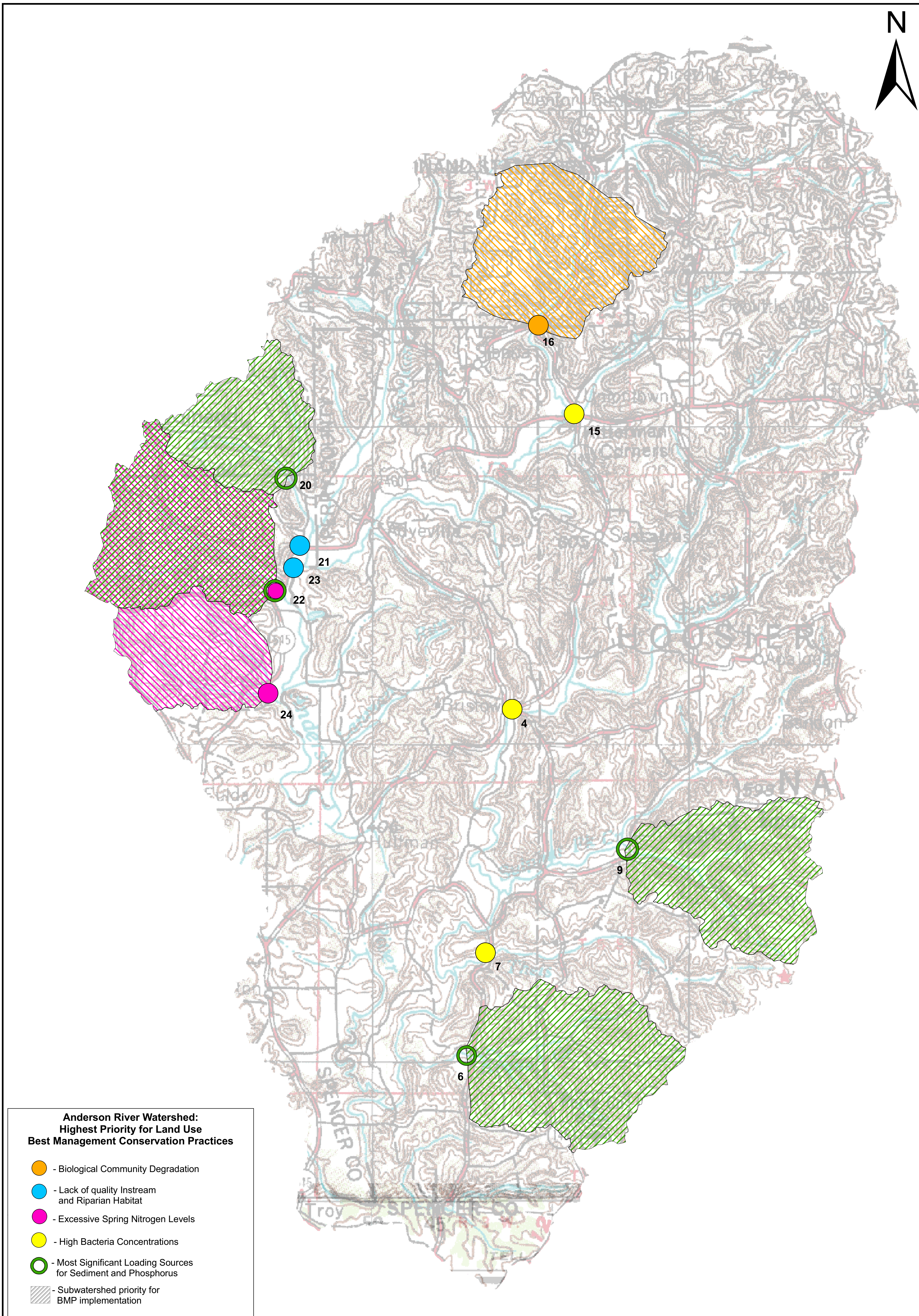
- The area delineated as Station 22, within the 5,769 acres of the Blackhawk Creek Subwatershed had the second highest amount for both sediment loading and phosphorus loading. The results were 0.32 tons/acre/year of sediment and 0.42 kg/acre/year of phosphorus. Additionally, this was the only station which was previously mentioned as a priority implementation area, as it also exhibited the second worst nitrate level.
- The area delineated as Station 6, within the 6,402 acres of the Kraus Creek Subwatershed had the third highest amount for both sediment loading and phosphorus loading. The results were 0.26 tons/acre/year of sediment and 0.35 kg/acre/year of phosphorus.
- The area delineated as Station 9, within the 5,584 acres of the Little Sulphur Creek Subwatershed had the fourth highest amount for both sediment loading and phosphorus loading. The results were 0.25 tons/acre/year of sediment and 0.34 kg/acre/year of phosphorus.

Many of these BMPs can be expensive, however there are many programs, such as those listed in Table 23 below, and many grant opportunities that are available to help defray the costs associated with these practices. Some potential sources of funding are listed below.

TABLE 23 POTENTIAL SOURCES OF FUNDING

Program	Emphasis
Indiana Department of Environmental Management, 319 Program	Non-point Source Pollution Planning and Implementation Funds
Indiana Department of Natural Resources, Lake and River Enhancement Program (LARE)	Non-point Source Pollution Planning and Implementation Funds
Indiana Department of Agriculture, Clean Water Indiana Grants Program	Help Fund County Soil and Water Conservation Districts Initiatives
Pheasants Forever	Grassland Establishment/Restoration
Quail Forever	Grassland Establishment/Restoration
Ducks Unlimited	Wetland Restoration and Creation
US Fish and Wildlife	North American Wetlands Conservation Act Grants

Many other opportunities may be found at www.grants.gov



DRAWING NO. XV

Highest Priority Locations for Land Use Best Management Conservation Practices

Anderson River Watershed Diagnostic Study

PROJECT NO: 06002	DESIGNED BY: EJB	SEAL:	
FILE NAME: N/A	DRAWN BY: MAK		
DATE: 4/23/07	CHECKED BY: EJB		
SCALE: NTS	PROJECT MNG: EJB		

REVISIONS

NO.	DATE	DESCRIPTION

V3 Companies
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630.724.9202 fax
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